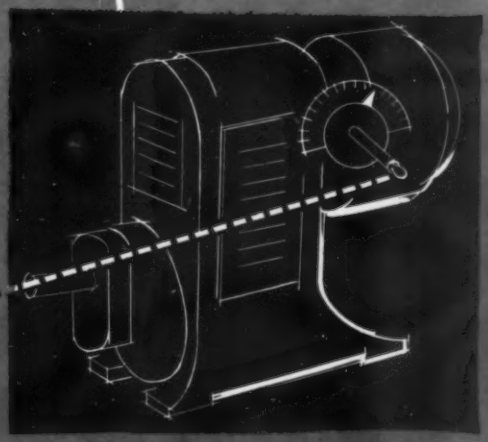
POWER TRANSMISSION DESIGN

DECEMBER 1959

OEM··MAINTENANCE

Latest Facts On Mechanical Adjustable Speed Drives



ALSO IN THIS ISSUE:

- Leadscrew Accuracy Magnified by Pantograph
- Mag-amp Drive Points Atlas Skyward
- Air-operated Clutch Selects Speeds

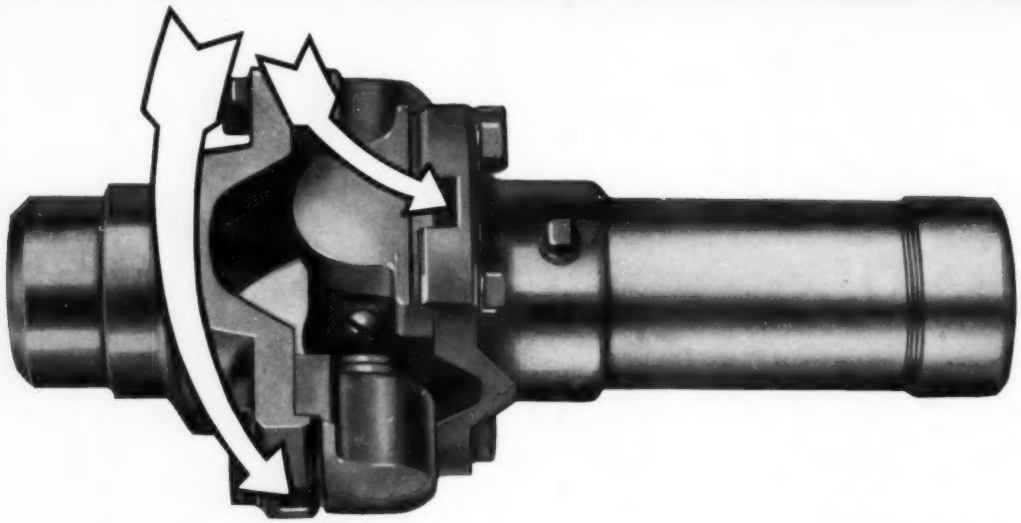
FREE CIRCULATION

THE MAGAZINE OF MACHINE DRIVES

News and ideas for designers and plant engineers who use power drive equipment

For SAFETY Drive Through KEYS ....

NOT Through BOLTS Nor SCREWS



Strong KEYS on the bearings—and corresponding KEYWAYS in the flanges—accurately machined from solid metal, transmit the torque in this largest capacity MECHANICS Roller Bearing UNIVERSAL JOINT. Two cap screws hold each bearing securely in place—their only function—and are locked in position. This KEY method of driving has the highest safety factor, transmits the most torque with the least weight, and avoids costly breakdowns resulting from driving through bolts or screws that wear loose and shear off.

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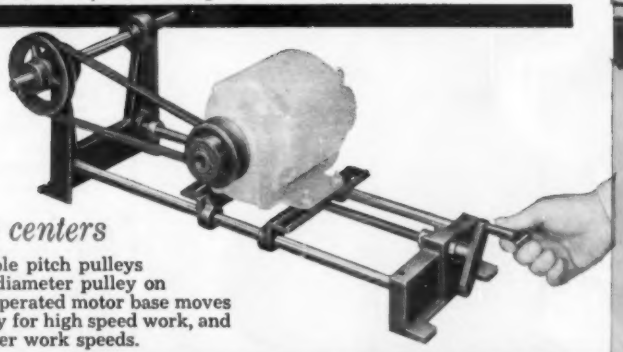
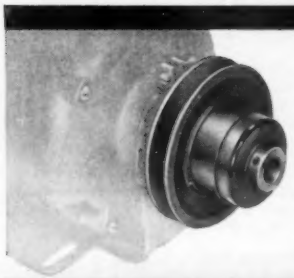
ratios up to 4:1, on 1/8 to 2 h.p. drives

1



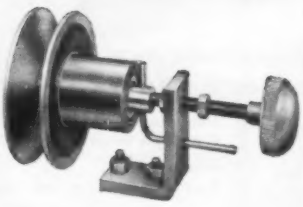
. . . with variable centers

With spring-loaded, variable pitch pulleys on motor shaft, and fixed diameter pulley on driven shaft. Hand wheel operated motor base moves motor close to driven pulley for high speed work, and away from pulley for slower work speeds.



AUTOMATIC
Spring Loaded Pulley. Belt pressure controls pitch diameter. 4 sizes: 3¼", 4", 5" and 6" O.D.

MANUAL
Spring Loaded Pulley. Hand wheel controls pitch diameter. 4 sizes: 3¼", 4", 5" and 6" O.D.

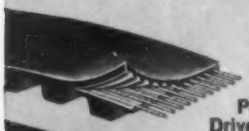


. . . with fixed center

Two variable pitch pulleys, one spring loaded and one manually operated, combined for maximum speed variation. Turning the hand wheel on the manual pulley varies its pitch. The slackening or tightening belt produces instant, automatic pitch adjustment of the spring loaded driver pulley for positive driving at the desired speed.

2

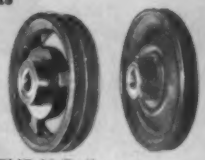
get more **drive** *with Maurey drives*



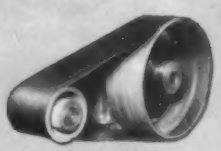
Positive Drive Belts

Variable Speed Belts

Mor-Grip V-Belts



Hi-Q FHP V-Pulleys



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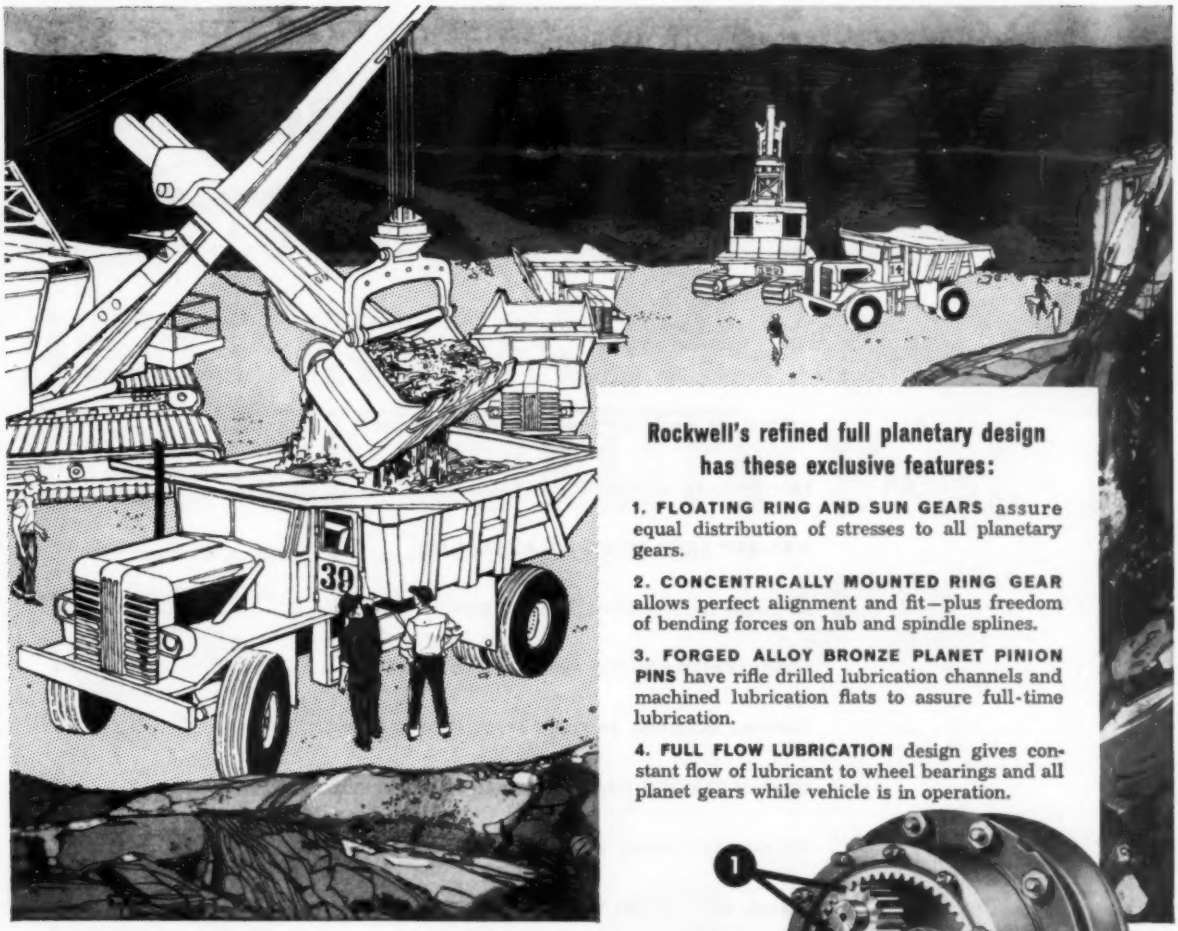

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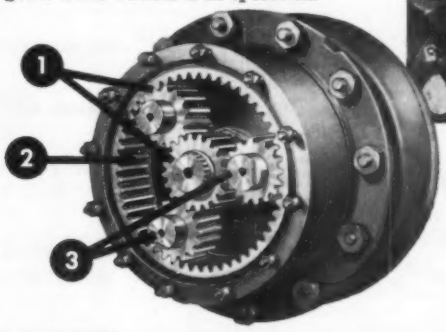
4. **FULL FLOW LUBRICATION** design gives constant flow of lubricant to wheel bearings and all planet gears while vehicle is in operation.



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BEST DRIVE FOR THE HEAVYWEIGHTS!"

Here's new rugged dependability for prime movers, four-wheel tractors, heavy off-road wagons, mining and agricultural equipment, and many other heavy-duty applications. Rockwell-Standard's complete line of planetary axles are available in capacities up to 150,000 pounds. And to meet every job need, there is a planetary steering axle operationally matched to each rigid planetary in the line.

The large reductions possible with Rockwell's full planetary, double-reduction axles enable them to ideally perform most heavy-duty off-highway operations. Because the substantial planetary reduction is located in the wheel hub, axle shafts and first reduction gears carry only nominal torsional loads—give long trouble-free service. For the best heavyweight drive, specify Timken-Detroit.

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DECEMBER 1959

volume 1 number 12

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FRANCHISE CIRCULATION

DISTILLED MAILING

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Before going further, tear out a Reader Service Card which you will find opposite page 64. Fill it out as you read and mail it when you're done. We'll act on your requests immediately.

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Here's Industry's MOST COMPLETE LINE OF QUALITY V-BELTS

DA 358 V-BELTS

For highly compact, plus-power drives. First major design change in Multiple V-Belts in the last 30 years.

DA POSITIVE DRIVE BELTS

Combines the advantages of the chain and gear with all of the advantages of the belt. No stretch, no metal to metal contact, no constant lubrication.

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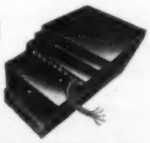
Pre-stretched link belting available in regular, oil-resistant and static-conductive types.

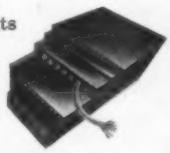
GENERAL DUTY V-BELTS

Power-balanced construction for flexibility, durability and strength.



STEEL CABLE V-BELTS

Steel cable permits no-stretch installation. All belts are fluoroscoped to assure extra high quality.



RAILROAD BELTING

High tensile strength, low stretch belting features high fastener tear-out resistance.

DOUBLE V-BELTS

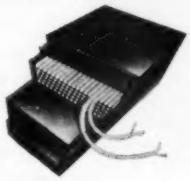
Relieved cross section assures maximum flex resistance. New control methods provide uniform cord section.

OPEN END V-BELTING

Used on drives where endless V-Belts are not practical. High fastener tear-out resistance.

RED SHIELD MULTIPLE V-BELTS

Red Shield Belts now offer 40 per cent extra capacity. Iso Dynamic matching and cord stability assure precise balance and long belt life. Also available in oil and heat resistant and static dissipating constructions.



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Abrasion resistant cover assures maximum life. Crowned cross section maintains stability under extreme loads.

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Look for the DA DURKEE ATWOOD SINCE 1910 *on your V-Belts*

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NEWS *from the power transmission field*

AGMA releases specification draft

CHICAGO, ILL.—The 1959 Semi-Annual Meeting of the American Gear Manufacturers Association was held Oct. 26-28 at the Edgewater Beach Hotel, Chicago.

Among the sessions held was the progress report on the new AGMA gear specification manual for spur, helical and herringbone gears. At that time copies of the proposed manual were released to members and the revised, completed manual scheduled for adoption by the Association in the spring of 1960.

The manual is intended to serve the mutual interests of the designer, purchaser and/or user of gears, and the gear industry itself. It is aimed especially at those responsible for the preparation or recommendation of gear specifications and drawings. It provides a guide in determining a satisfactory selection of gearing ranging from cast tooth gearing, where pitch line velocities are relatively low and economy is a prime consideration, through precision classes of gearing requiring extreme accuracy and/or high speeds. The manual includes a wide range of pitches, from fine pitch, 20 D.P. and finer (up to 10 in. diameter), and coarse pitch, from 19.9 D.P. to ½ D.P. with diameters up to 200 in.

Benefits to the gear user are expected to include better comparison among gear manufacturers, more accurate knowledge of gearing needed for a particular application and quicker obtaining of parts, and an increased expectation of dependable performance. In addition to giving the manufacturer uniform basic specifications, the manual will provide a common reference standard for application and inspection data.

Most of the information is presented in tabular or graph form.

Included are sections on definitions, nomenclature, ratings and performance, accessories, shipment and installation, and weather protection. Copies may be obtained for $1.00 per copy from NEMA headquarters, 155 East 44th Street, New York.

NEMA approves new standards

NEW YORK, N. Y.—A wide variety of information of practical value to both manufacturers and users of gas turbines has been compiled in a new standards publication approved by the National Electrical Manufacturers Association.

Designated "Gas Turbine Power Plants, SM 30-1959," the publication was developed by NEMA's gas turbine group and represents the result of two years of work by top engineers from all domestic producers in this area of the prime mover field. Data covers horizontal gas turbine power plants used for stationary mechanical drive or for power generation land installation.

Norma-Hoffman to make more traction bearings

STAMFORD, CONN.—A fifty percent expansion in capacity to produce railway traction motor bearings is under way at Norma-Hoffman Bearings Corp., Stamford. Extra machinery and equipment recently acquired by the company will be used for increased production schedules beginning in January.

Norma-Hoffman is one of the few manufacturers of this special type of cylindrical roller bearing, used to support traction motors of diesel-electric and electric locomotives. The bearings must sustain loads of varying direction and magnitude reliably over operating periods of many years and many hundreds of thousands of miles.

Hydro-Air platform flies at 50 mph

WASHINGTON, D.C.—A new flying platform, a ship-plane hybrid named the Hydro-Air, was unveiled last month by Spacetronics, Inc. of Washington.

Spacetronics now is making a full-size Hydro-Air as a prototype of a cargo-carrying craft intended to travel between ports while held above water by a column of air. Originated and developed by the company's engineers, the machine is being built of aluminum extrusions and sheet, supplied by Aluminum Company of America. The light metal shell is packed with styrofoam to give buoyancy and additional strength.

The tear-drop-shaped vehicle is 32 feet long, 24 feet across at the widest point, and two feet high. A horizontal rotating propeller is housed in the bow. The prop pumps and maintains a large volume of air in the space between the platform and the surface of the water.

Air pressure, though rated at only a few ounces per sq inch, has sufficient upward push to lift the Hydro-Air about two feet. Once the machine is aloft, friction is practically eliminated and high speeds can be obtained with only a fraction of the power normally required. Propulsion is provided by aft-mounted fans. Engineers anticipate top speeds of more than 50 mph, and expect that the air cushion will prevent any heavy spray from developing during operation.

The picture at left shows the specially-designed propeller that pumps air beneath the flying platform.

Louis Allis begins new research center

MILWAUKEE, WISC.—The Louis Allis Company, Milwaukee, which manufactures electric motors, generators, and adjustable speed drives, has announced the construction of a new research and development center in the nearby suburb of Greendale. The building, which will be staffed by 100 engineers and technicians, will double the size of the present engineering and physics laboratories.

According to T. R. Wieseman, vice president in charge of engineering, the company's research and development plans include electronic and nuclear areas which will permit greater activity in industrial and military fields.

Fawick adds hydraulic division

CLEVELAND, OHIO—With the acquisition of New Products Corporation of Skokie, Ill., Fawick Corporation of Cleveland has established a new Hydraulic-Electronic Division. The new division becomes the third within the corporation, the other two being Fawick Airflex and Fawick Automotive Brake. Ray G. Holt has been named manager of the division.

Development and production transferred to Cleveland include hydraulic power steering valves, flow divider and relief valves, hydraulic pumps, fuel pumps, fuel selector valves and other fluid power products.

New vulcanizer saves time

TRENTON, N. J.—The production and dollar savings of a new heat-regulated V-belt curing unit, designed by engineers of H. K. Porter Co., Inc., Trenton, is already 33 percent greater than the model used previously.

The heart of the new vertical vulcanizer is a quick change mold with a doubled V-belt capacity. The design of the vulcanizer yields faster curing, less material handling, more uniform belt size and a smoother finish. Because of these results, eleven more units will soon be in operation at the Thermoid Works, Porter division. A cylindrical steel mold carrying the belts to be cured is hooked to a chain and maneuvered by automatic controls. It can be lowered into the tank or taken out in a few seconds, so that the mold is always hot and no warmup time is necessary.

To begin the curing operation, belts are placed over the steel mold and then fitted into a bag, or sleeve. The mold is then lowered into a vertical tank built to high temperature and pressure specifications. This tank is sealed off, and the belts are cured between the bag and the steel cylinder.

Formsprag buys Rawson Division

DETROIT, MICH.—Formsprag Company, Warren, Mich., has purchased the Rawson Division of the O. S. Walker Co. in Worcester, Mass., and has completed the transfer of the operation to its Detroit plant. The Rawson Division has been the manufacturer of a patented centrifugal clutch widely used for many years.

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FLEXIBLE SHAFTING
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IN STANDARD SIZES FROM
¼" TO 1¼" WITH NON-RAVEL CORES
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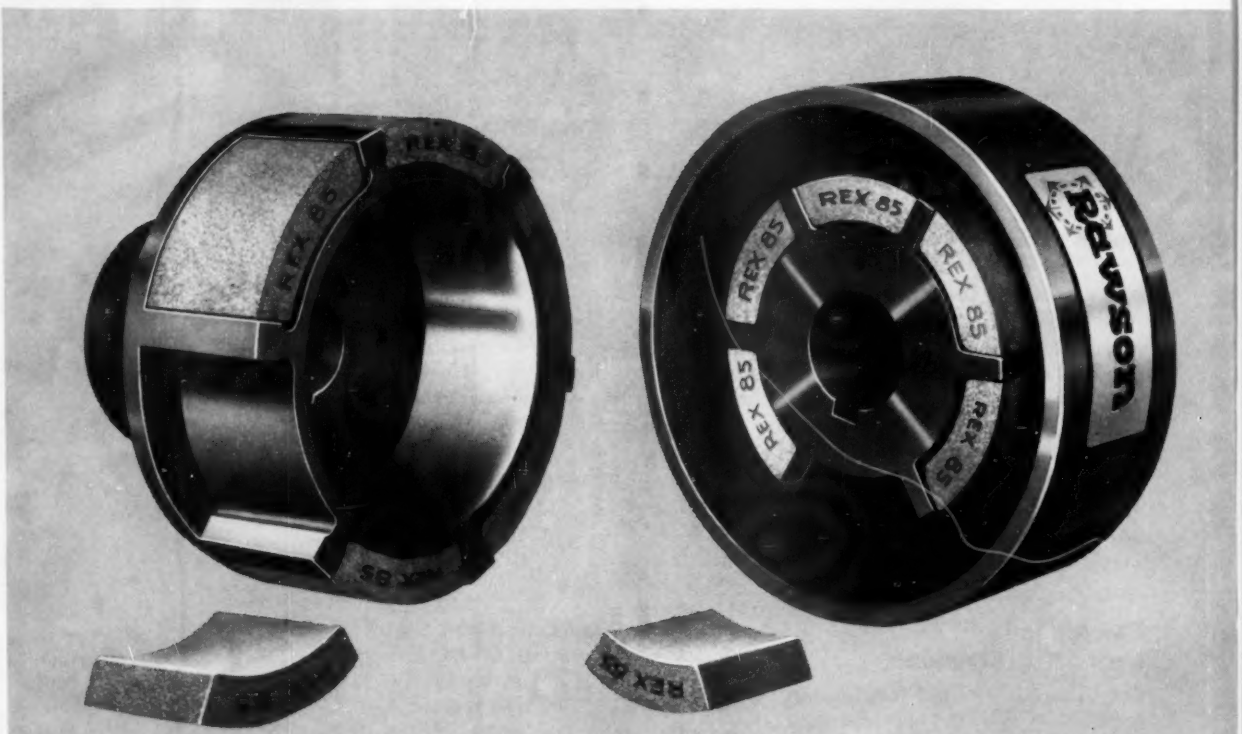

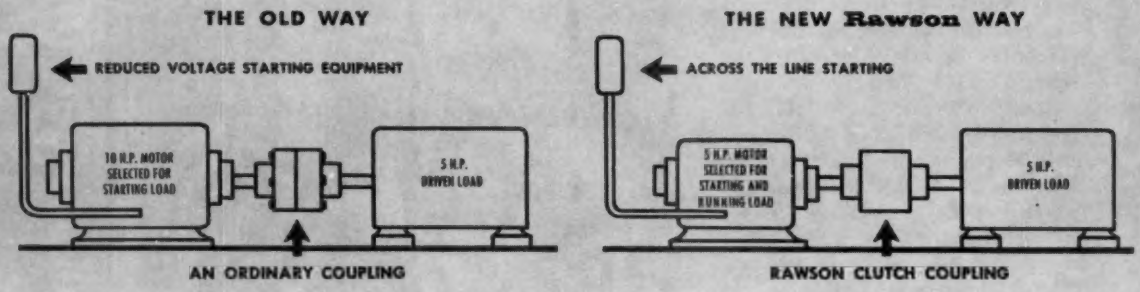
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REDUCED VOLTAGE STARTING EQUIPMENT
10 H.P. MOTOR SELECTED FOR STARTING LOAD
5 H.P. DRIVEN LOAD
AN ORDINARY COUPLING
THE NEW Rawson WAY
ACROSS THE LINE STARTING
5 H.P. MOTOR SELECTED FOR STARTING AND RUNNING LOAD
5 H.P. DRIVEN LOAD
RAWSON CLUTCH COUPLING

Check These Additional Features of

- Exclusive all-metal shoes permit higher operating temperatures, assure longer life.
- For power applications up to 2,000 horsepower, drive in either direction.
- Fluid-smooth starting without the power loss of fluid types at full load R.P.M.
- Protects the most delicate equipment by eliminating starting shock.
- No dangerous prolonged surge current when high-inertia equipment is started.
- All-metal shoes never need adjusting, entirely mechanical operation assures longer life.

. . . Lower Starting Equipment Costs . . .

. . . Secure Automatic Overload Protection

With Rawson

Centrifugal Clutches

The Rawson is an all-metal centrifugal clutch that drives in either direction and provides: *no-load* starts for motors—cushioned starting of equipment at predetermined R.P.M.—automatic overload protection—slip-free power at normal operating speeds—rugged design for applications up to 2,000 horsepower.

Results: "no-load" starting decreases acceleration time and starting current—across-the-line starting can be used instead of costly reduced voltage equipment—based on lower starting load, smaller motors can often be employed—cushioned starting of high inertia loads frequently permits using NEMA B or standard squirrel-cage motors instead of expensive special high-torque motors—delicate equipment is protected by eliminating starting shock—jamming or overloading of driven equipment will cause the clutch to slip, providing protection for motor.

Rawson clutches function as direct-drive clutch-couplings (in-line, shaft-to-shaft connection) or as indirect-drive clutches through V-belts, chains or gearing. They can be furnished with delayed engagement for standby or dual drive installations.

Rawson clutches are simple in design, they never require adjustment, and are entirely mechanical in operation for trouble-free performance. For higher efficiency, lower costs, reduced maintenance and full protection for even the most delicate equipment, specify Rawson centrifugal clutches and clutch-couplings.

Ask your Rawson distributor or write directly to us for your free copy of Rawson Catalog No. 141.

FORMSPRAG COMPANY
23587 Hoover Road, Dept. 109
Warren (Detroit), Michigan

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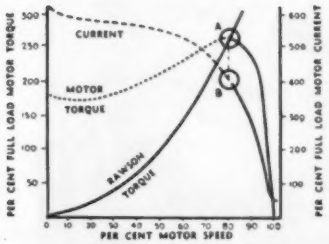


Typical torque and current characteristics of a standard NEMA B motor. Because Rawson clutch does not fully engage until after peak torque speed "A" is reached, motor acceleration time is much faster, peak current period is greatly decreased and motor operates more efficiently "B". Thus, smaller motors and across-the-line starting can be used.

Rawson Clutches

- **No-load starting reduces motor acceleration time to a fraction of a second.**
- **Full power at normal operating R.P.M.—No Slip, No Power Loss, No Heat.**
- **Rugged design and all-metal construction keep maintenance requirements to a minimum.**

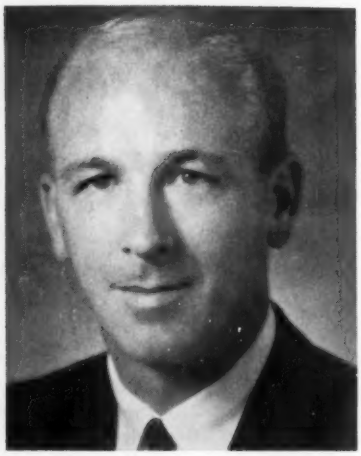
THERE IS A FORMSPRAG OVER-RUNNING CLUTCH FOR EVERY OVER-RUNNING, INDEXING & BACKSTOPPING APPLICATION

Modern Formsprag over-running clutches are universally used by automotive, aircraft and other industries. They provide greatest torque for size and weight, higher precision and no measurable backlash. Torque capacities range from 50 lbs. in. to 136,500 lbs. ft. Standard bore sizes from ¼ " to 12". Our engineering department will design special Formsprag clutches for your unusual applications. Write for your copy of Formsprag catalog.

For more information Circle No. 14 on Reader Service Card

MEN of the power transmission industry

Cooper



Napp

Diamond Chain names two to manager posts

INDIANAPOLIS, IND.—Jack E. Cooper has been named manager of sales for Diamond Chain Company, Indianapolis subsidiary of American Steel Foundries, Inc. Cooper succeeds A. S. Basten, who recently retired after forty years in the chain industry. Cooper, who was formerly assistant to the sales manager, also served in Diamond's Chicago and Atlanta offices for several years.

The appointment of R. W. Napp as manager of the Chicago office of Diamond Chain was announced at the same time. Napp, who has been assistant manager for the past ten years, succeeds D. G. Viskniskki.

H. B. Biersdorfer, formerly district manager of the Cleveland office, has been promoted to manager of market research at the Indianapolis office.

SKF names Smith to chief engineer post

PHILADELPHIA, PA.—Bruce M. Smith is the newly-appointed chief industrial engineer for SKF Industries, Inc. Smith fills a post left vacant by Stuart J. Northrop, who is now mechanical superintendent.

In his new post with the ball and roller bearing manufacturer, Smith will be responsible for the establishment and administration of industrial engineering policies and procedures. Prior to his association with SKF, Smith was director of industrial engineering for The Standard Products Co., Cleveland.

Twin Disc names two

RACINE, WISC.—Twin Disc Clutch Company, Racine, has announced the promotions of E. B. Falk to director of advertising and public relations, and Robert Smith to public relations manager.

Falk joined Twin Disc in 1946 and was most recently manager of advertising and sales promotion. Smith rejoined the company recently, after serving for four years as public relations director of a non-industrial national organization.

De Laval names manager

TRENTON, N. J.—Charles A. Jurgensen, vice president of manufacturing of De Laval Steam Turbine Company, Trenton, has announced the appointment of Paul S. Nurko as works manager of the company. Before this promotion Nurko was general superintendent of the manufacturing division.

Nurko joined De Laval's testing department in 1939 and later transferred to the research and development department.

Jackson

Bourne

Vice presidents at Boston Woven Hose

CAMBRIDGE, MASS.—Randolph H. Jackson has been named vice president in charge of sales for the Boston Woven Hose & Rubber Division of the American Biltrite Rubber Co., Cambridge. This is a new position in the organization where Jackson has been director of sales for the past three years. Previously Jackson was connected with American Pulley Co.

Mason also announced the appointment of Harry A. Bourne to the position of vice president in charge of manufacturing of the same division. Bourne was factory manager during the past two years.

Conlon

Burton

Marketing, sales officers at Dayton Rubber division

DAYTON, OHIO—Joseph A. Conlon has been named marketing manager of the Dayton Industrial Products Company, Robert G. Burson, vice president, announced. DIPCO is a newly-formed division of Dayton Rubber Co.

In his newly-created post, Conlon will coordinate merchandising, distribution and sales programs for DIPCO's diversified product line and will concentrate initially on programs for belts and hose in the automotive and industrial fields, Burson said. Prior to his appointment, Conlon served 26 years with U.S. Rubber Co., most recently as staff marketing manager in New York City.

Other DIPCO news includes the appointments of Robert J. Burton and Joseph B. Strahan as district sales managers in the northern Wisconsin-Michigan peninsula and the Los Angeles-Bakersfield areas respectively. Both men will handle the company's complete line of industrial V-belts, cog belts, hose, tapes and molded products.

Strahan

Link-Belt names marketing and sales managers

CHICAGO, ILL.—New marketing manager of Link-Belt Company's Ewart plant in Indianapolis is Charles W. Beauchamp, who was formerly assistant sales manager for the Ewart plant. Beauchamp will direct all sales activities of the plant.

Aiding Beauchamp in his new position will be Kendrick M. Hickman, newly-appointed sales manager of the plant. Hickman has served the company in the positions of manager of agricultural sales and assistant manager of sales for the Ewart plant.

Both appointments follow the retirement of Forest H. Spencer, former sales manager of the plant. Spencer had been with the company for forty years.

Beauchamp

Save $ $ $ $

ATLAS UNIVERSAL JOINTS

Balanced to operate without vibration at all speeds. Short, stubby jaws give maximum resistance to spread. Larger diameter joints fitted with big grease reservoir. Standard alloy steel joints in fifteen sizes for all requirements. Also made in Bronze, Monel and other special metals.

Universal Slip Shafts a specialty.

WRITE for illustrated catalog giving data and specifications.

WEST COAST REPRESENTATIVES

LINK-BELT CO.

Los Angeles
Portland
Seattle

GRAY & PRIOR

San Francisco
Oakland
Spokane

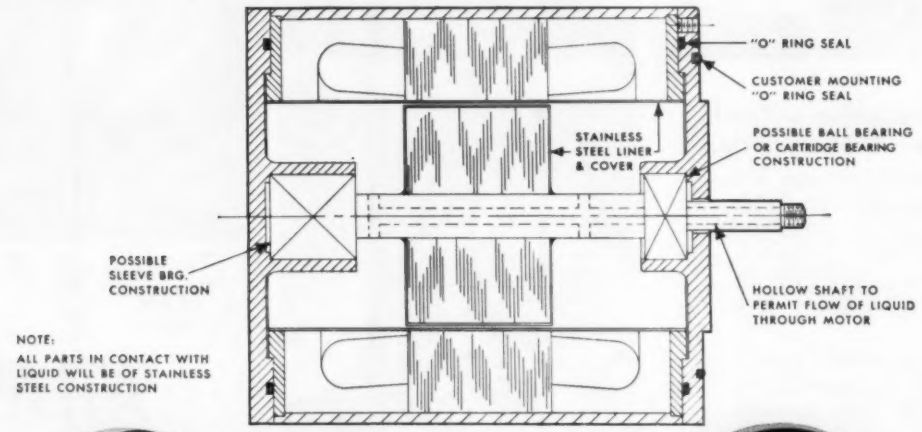
THE GRAY & PRIOR MACHINE CO.

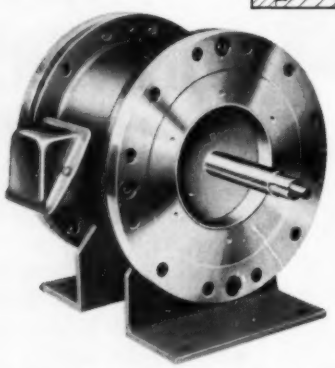
607 WINDSOR ST.
HARTFORD 1, CONN.

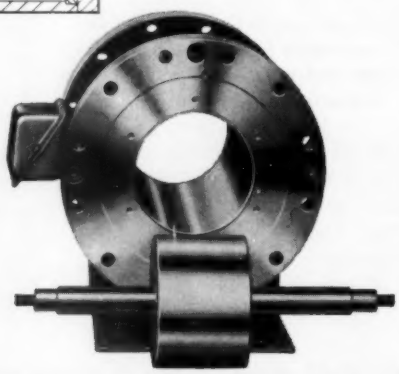
Circle No. 15 on Reader Service Card

COMPLETELY SEALED STAINLESS PUMP MOTOR

for handling nuclear contaminated, highly corrosive or highly volatile fluids


"O" RING SEAL
CUSTOMER MOUNTING "O" RING SEAL
STAINLESS STEEL LINER & COVER
POSSIBLE BALL BEARING OR CARTRIDGE BEARING CONSTRUCTION
POSSIBLE SLEEVE BRG. CONSTRUCTION
HOLLOW SHAFT TO PERMIT FLOW OF LIQUID THROUGH MOTOR
NOTE:
ALL PARTS IN CONTACT WITH LIQUID WILL BE OF STAINLESS STEEL CONSTRUCTION





This stainless steel, canned motor in ½ HP to 5 HP sizes follows NEMA specifications for the next higher horsepower at the same motor speed. Bearing type and material depend on the liquid being pumped. Stainless ball bearings, carbon block, glass, teflon, sintered bronze, teflon impregnated bronze and other materials can be used.

Liners and covers are all welded to form a perfect seal over each welded surface. End brackets are attached with "O" ring seals.

The motor can be submerged, but doesn't have to be. All units are special construction.

Our engineers will work with you on your applications.

PEERLESS ELECTRIC DIVISION — 1512 W. MARKET ST.

PORTER

H. K. PORTER COMPANY, INC. — WARREN, OHIO

PORTER SERVES INDUSTRY: with Rubber and Friction Products—THERMOID DIVISION; Electrical Equipment—DELTA-STAR ELECTRIC DIVISION, NATIONAL ELECTRIC DIVISION, PEERLESS ELECTRIC DIVISION; Specialty Alloys—RIVERSIDE-ALLOY METAL DIVISION; Refractories—REFRACTORIES DIVISION; Electric Furnace Steel—CONNORS STEEL DIVISION, VULCAN-KIDD STEEL DIVISION; Fabricated Products—DISSTON DIVISION, FORGE AND FITTINGS DIVISION, LESCHEN WIRE ROPE DIVISION, MOULDINGS DIVISION, H. K. PORTER COMPANY de MEXICO, S. A., and in Canada, Refractories, "Disston" Tools, "Federal" Wire and Cable, "Nepcoduct" Systems—H. K. PORTER COMPANY (CANADA) LTD.

For more information circle No. 20 on the Reader Service Card

LETTERS

Address letters to:
The Editor
Power Transmission Design
812 Huron Road, Cleveland 15, Ohio

Tearsheets

Gentlemen:

One of the features of your magazine that I particularly like is the monthly section of ideas and developments entitled "Bearings, Design/Application." This is useful because the information is current and cannot be found elsewhere.

Unfortunately, I did not remove that section from the September issue. If tear sheets from that issue are available, therefore, I shall greatly appreciate a copy to complete my file.

C. L. LINDSAY
Chief Engineer
Skinner Engine Co.
Erie, Pennsylvania

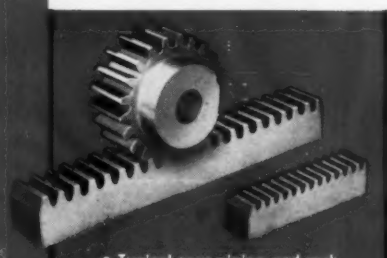
Omission

. . . . . We have received your October 1959 issue of POWER TRANSMISSION DESIGN and observed with interest your article on sleeve bearings. It is nicely done and brings out the fact that sleeve bearings can do an excellent job when properly designed and lubricated. We consider, however, that your list of sleeve bearing manufacturers is less than worthy of your able publication. While it is easy to understand that in an operation such as yours it is possible for the right hand not to know what the left is doing, we wish to direct your attention to the fact that we manufacture more cast bronze sleeve bearings than most of the other manufacturers you have listed . . . .

C. F. LANGFORD, President
Superior Kendrick Bearings, Inc.
Detroit, Michigan

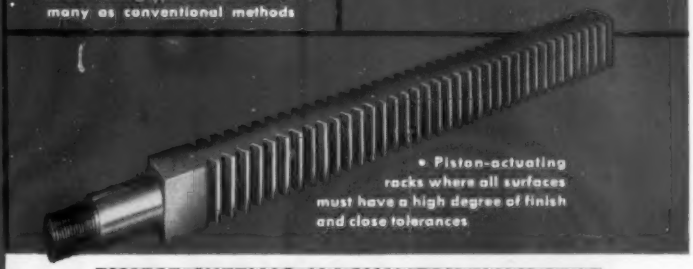
We apologize for this omission and we are very conscious of the fact that Superior Kendrick does indeed manufacture this kind of product.—Ed.

NOW-PRECISION RACKS
on a
Commercial Price basis



• Typical spur pinion and rack. Short pieces as shown here can be cut two at a time with a single broach pass and not more than two passes. Longer racks require more cutting passes but not as many as conventional methods

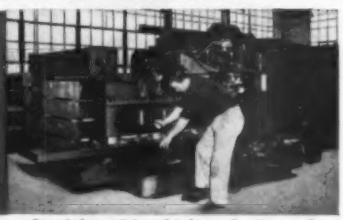
• Heat treated alloy steel double racks 75" long overall 2 D.P., 6" face, for blast furnaces



• Piston-actuating racks where all surfaces must have a high degree of finish and close tolerances

FINEST CUTTING MACHINERY AVAILABLE

• Large surface grinder, 42" dia. wheel, for grinding rack blanks 10" x 17" x 64" long on all four sides within .002" square, flat and parallel before tooth cutting



• Special precision, high production rack-cutting machine designed and built by BRAD FOOTE. Racks in illustration are used in precision glass-polishing machinery

RACKS
IN LARGE QUANTITIES
Spur or Helical Teeth
16 D.P. to 4" Circular Pitch
Practically Any Shape of Blanks
Closer Tooth-Spacing Limits
Much Better Profile Finishes
Accurate Parallelism and Lead

• We also have conventional rack-cutting equipment and manufacture racks of all sizes and shapes in single piece lots and smaller quantities where production tooling would not be required.

BRAD FOOTE makes any type of gear and speed reducers, transmissions and intricate power units. All are famous for long, satisfactory service. Why not discuss your requirements with our engineering staff, let us make recommendations or quote on your specifications. It can cost you much more to settle for less than BRAD FOOTE quality and service.

BRAD FOOTE GEAR WORKS, INC.
MEMBER OF AGMA
1313 South Cicero Avenue • Cicero 50, Illinois
Bishop 2-1070 • OLympic 2-7700
subsidiary of PITTSBURGH GEAR COMPANY, Neville Island • Pittsburgh 25, Pa., Phone: SPaulding 1-4600
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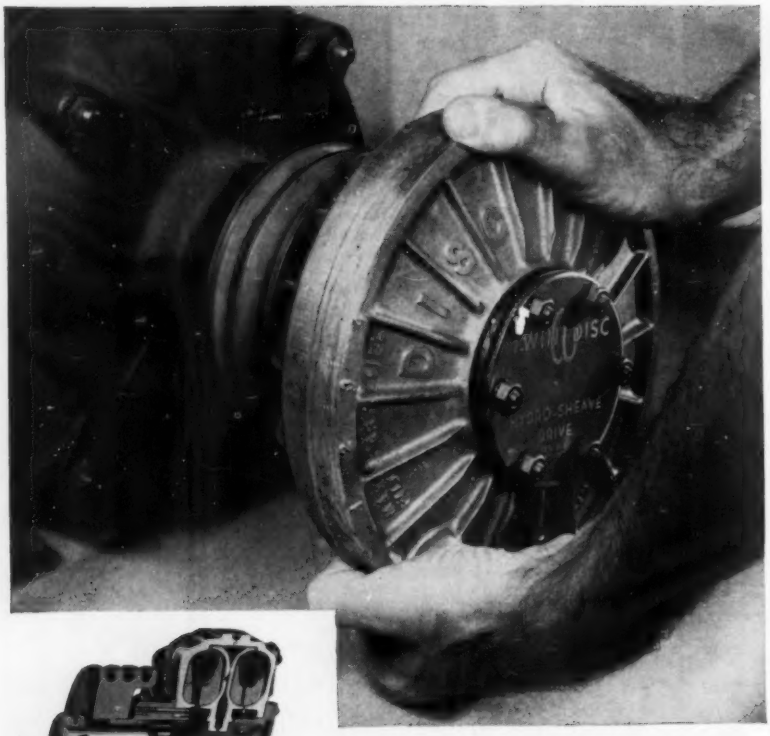
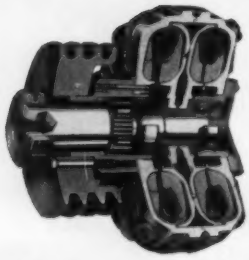




Convert to FLUID drive in only 5 MINUTES!

Fluid drive in a package . . . complete, ready-to-install . . . slips right over the motor shaft, easily in a matter of minutes. That's the Twin Disc HYDRO-SHEAVE® Drive—compiling new records for high production and low equipment maintenance.

Here's what the HYDRO-SHEAVE does

1. Reduces starting current demands . . . provides smooth, fast motor acceleration.
2. Protects against motor overloads, stalling and burn-outs.
3. Transmits full motor torque at all speeds.
4. Cushions out destructive vibrations and shocks, protecting both driving and driven equipment.
5. Permits motor selection based on running load rather than starting load.

Twin Disc Fluid Drives are available as HYDRO-SHEAVE Drives, from ¾ to 50 hp; Fluid Couplings from ¾ to 850 hp; and HYDRO-WYND® Drives, Models 8.4 and 12.2 for winding and tensioning.

Write today for full details on these profitable fluid drives. See how easily they will solve your power transmission problems. Request Bulletins 144-D and 145-C, from Dept. DS, Racine, Wisconsin.

TWIN DISC
Fluid Couplings

TWIN DISC CLUTCH COMPANY, Racine, Wisconsin • HYDRAULIC DIVISION, Rockford, Illinois

Branches or Sales Engineering Offices: Cleveland • Dallas • Los Angeles • Newark • New Orleans

Fluid drives solve power transmission problems

To solve power transmission problems that *cut work output* and *raise costly downtime* on oil field equipment—an ever increasing number of manufacturers *and* users specify various types of fluid drives.

Today, there are several types of these drives available, including fluid couplings, and single-stage or three-stage torque converters.

The fluid coupling is most widely used on equipment not requiring torque multiplication, but needing the shock cushioning characteristics of *fluid*.

The single-stage torque converter is found most frequently where oil field equipment needs only *mild* torque multiplication. Possibly a simple fluid coupling has been used in the past, so installation of a single-stage torque converter can "modernize" machinery without a complete redesign.

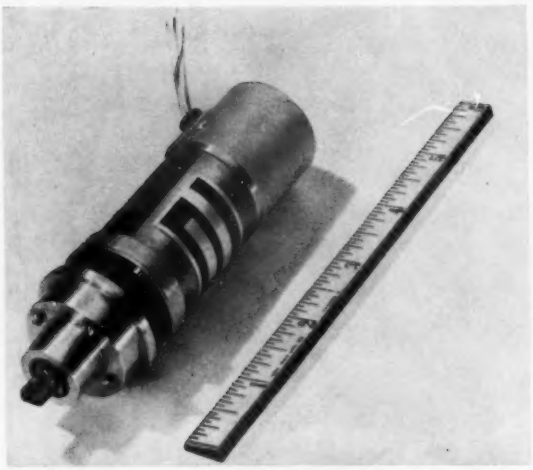
The three-stage torque converter —with multiplication up to 6:1—is usually found when it is desired to maintain nearly governed engine speed—with maximum power output over a wide range—and to produce high torque ratios for hoisting or heavily loaded vehicles.

Whatever the equipment, whatever the application, the Twin Disc Clutch Company offers the only *complete* line of industrial fluid drives available for dependably transmitting power to driven equipment. Fluid couplings are provided in a variety of models for engines and motors from ¾ to 850 hp . . . and torque converters, both single-stage *and* three-stage, are available for engines from 30 to 1000 hp.

If *you* have a power transmission problem, and if you feel that a fluid drive will help solve it, *consult* Twin Disc Specialists for unbiased recommendations as to which drive is best suited to your particular operation.

For more information Circle No. 26 on Reader Service Card

NEW PRODUCTS

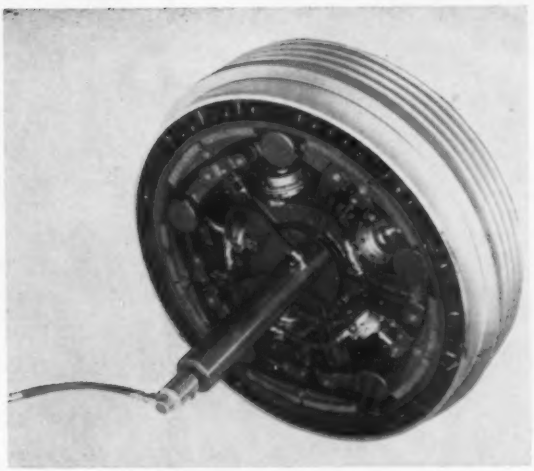


Miniature motor with integral parts

New Type GJ d-c motors are 1⅜ in. diameter, have continuous duty ratings to 1/100 hp, and can be wound for series, split-series, shunt or universal operation. Units are designed to meet MIL environmental specifications, and, with filters, MIL radio noise specifications. Length of the motor is determined by the stack length chosen. A particular feature of Type GJ motors is that torque to 6 oz-in. can be obtained for intermittent duty. They lend themselves to integral brakes which are capable of full load speed stops in 2.9 revolutions. Brake adds 1⅛ in. to over-all motor length. Various types of governors may be used, and integral planetary gear speed reducers are available in hundreds of ratios. Units use 6 to 75 v d-c, and provide output speeds from 6,000 to 13,000 rpm.

Globe Industries, Inc., Dayton, Ohio.

Circle No. 200 on the Reader Service Card



Air-Cooled clutch for tension control

Air-cooled and air-actuated slip clutch takes the guesswork out of center winding tension control, and obviates the use of clumsier and less dependable units like mechanical slip clutches or slipping belts. An air gauge shows the operator the pressure at which the clutch is operating and what tension is on the roll material, thus helping the operator to avoid rough estimates. One pressure regulating control, automatic or manual, operates the clutch. Tension is varied by air pressure fed to friction shoes which press against the clutch face, giving a steady, even torque. The unit is designed to dissipate heat and give uniform torque output at intermediate speeds. Suitable for both light and heavy duty installations, the clutches were developed for use in the paper and textile industries.

Horton Mfg. Co., Inc., Minneapolis, Minn.

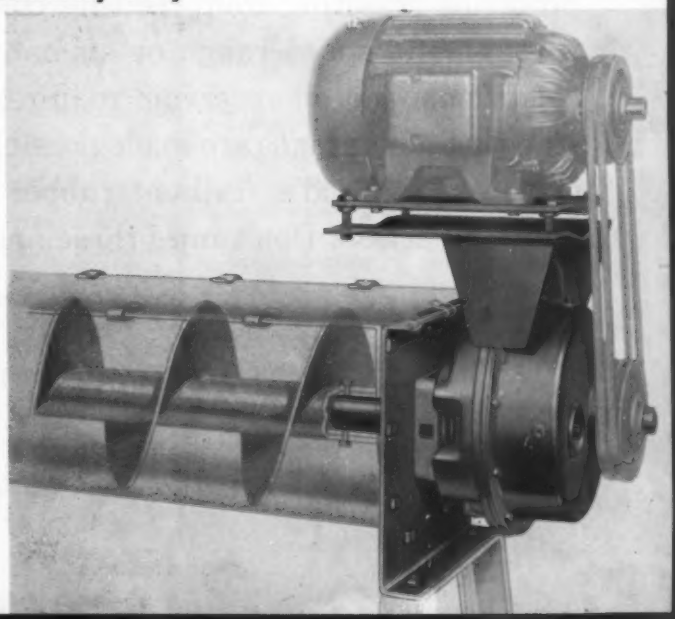
Circle No. 201 on the Reader Service Card

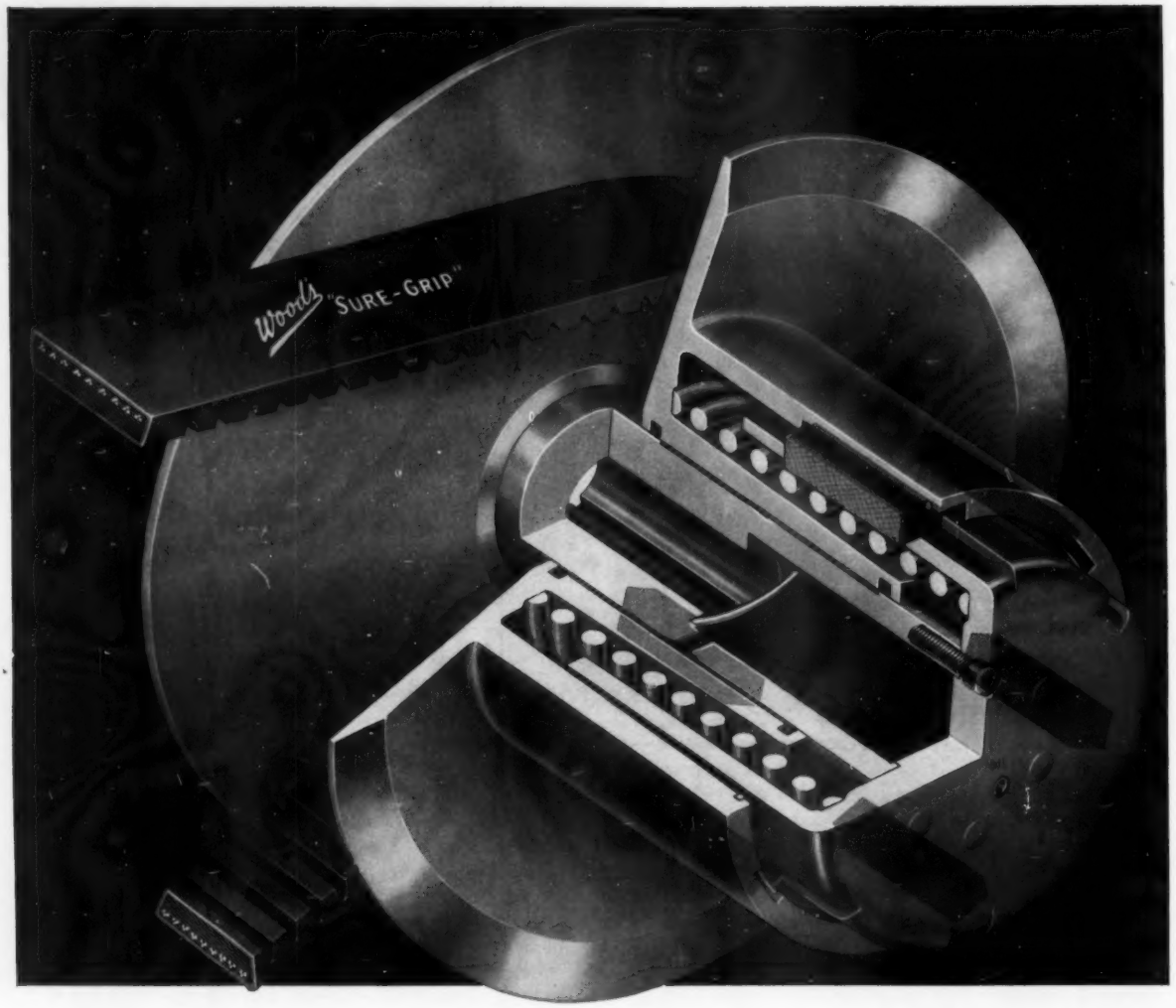
Complete screw conveyor drive makes assembly easy

New compact helical gear drive, designed especially for screw conveyor installations, was developed as the result of extensive field research. Various drive assemblies can be furnished from stock, and the basic drive (reducer with drive shaft and seal housing) can be combined with standard trough end or with company's all-steel Motor Mount. Drives are manufactured in six sizes, each with ratios of 4, 9, 14 and 24 to 1, assuring correct selections for all conveyors requiring ½ to 30 hp. Drive shafts are removable by means of a quick snap ring arrangement, and can often be removed without disturbing reducer or screw. Tapered roller bearings absorb thrust. Trough ends, available in eight sizes from 6 to 20 in., bolt to any standard trough. Choice of seals (waste packing, felt seal or lip seal, either leather or neoprene) is offered.

The Falk Corp., Milwaukee, Wisc.

Circle No. 202 on the Reader Service Card





new, revolutionary, unique—won't freeze, won't stick—Here, for the first time, is a variable speed sheave that won't freeze, won't stick. It's Wood's new "MS" motion control sheave and it completely eliminates problems resulting from fretting corrosion. No more downtime, running through the speed range or dismantling. And, under normal operating conditions, the oil reservoir requires checking only twice a year. These startling advantages are made possible by two exclusive and revolutionary features . . . Wood's resilient rubber keys and continuous, rotational oil pumping action. Don't miss these and many other advantages.

send for bulletin 4101

Woods

T. B. WOOD'S SONS COMPANY
CHAMBERSBURG, PENNSYLVANIA
ATLANTA • CAMBRIDGE • CHICAGO • CLEVELAND • DALLAS

For more information Circle No. 28 on Reader Service Card

CONTINUED *from page 15*

Motor pulley

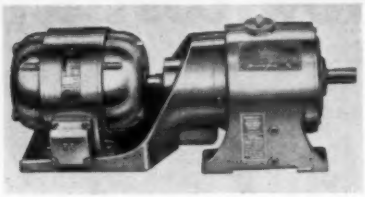
Variable-speed drive motor pulley in sizes 1 to 15 hp is the latest in company's line of speed adjusters. It features an all-area greasing system, with free distribution of grease to bearing points, a single lubrication point on the end of the pulley, and an exclusive grease reservoir for easier maintenance and longer life. Pulley can be mounted on company's anglematic motor base which is designed to keep proper belt tension through the entire range of speed change.

Worthington Corp., Harrison, N. J.

Circle number 203 on reader service card

All-motor reducers

Gear reducer packages in ratings from ½ to 50 hp. Single, double and triple reductions, output shaft speeds from 520 through 9 rpm for nearly unlimited selection of special drive motor and reducer combinations, all



from one source. Typical motors used include multi-speed, wound rotor slip ring, squirrel cage, crane-hoist and torque.

Reuland Electric Co., Alhambra, Calif.

Circle number 204 on reader service card

Roller chain calculator

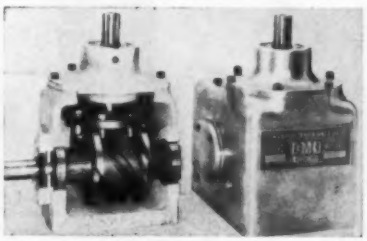
Slide rule-type calculator for computing the proper roller chain for every type of drive includes all necessary data. Step 1 covers the service factor and design hp. Step 2 gives number of teeth required in driving sprocket. Step 3 selects sprocket size for the drive shaft. Steps 4 to 8 give selection data on sprockets. Step 9 shows how to obtain total chain length in pitches. Step 10 converts length in pitches to length in feet or inches.

Atlas Chain & Mfg. Co., West Pittston, Pa.

Circle number 205 on reader service card

Indexing drive unit

Speeds up to 1000 indexes per minute in versatile, low-cost series. Output torque ratings of 1100 in.-lb and up. High torque output enables unit to handle a high combined load of inertia and work done during movement. Standard indexing periods of



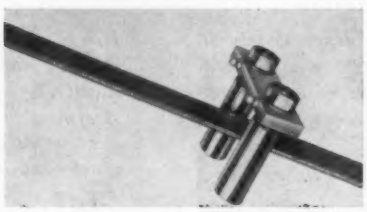
270, 180 or 120 deg with 3, 4, 6, 8 and 12 stops, left- or right-hand cams.

Commercial Cam & Machine Co., Chicago, Ill.

Circle number 206 on reader service card

Belt guide roller

Anti-friction belt guide prevents power loss from slippage and increases belt life. Guide can be used at high belt speeds with infrequent relubrication. Guide consists of one roller bearing and one ball bearing fitted in a sleeve so that outer rings are stationary. Bearings are sealed



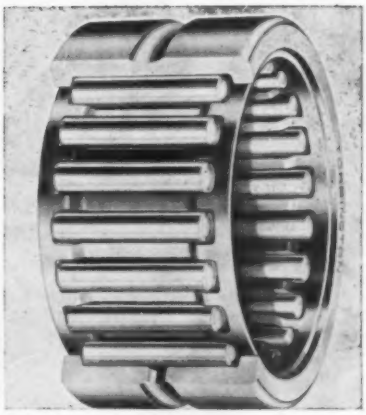
against dirt. Adaptable to all cases where fork guides are used.

SKF Industries, Inc., Philadelphia, Pa.

Circle number 207 on reader service card

Roller bearing series

Channel-shaped outer ring roller bearings have new cage design that permits application at speeds higher than those possible with full complement types. Longer and larger rollers give greater capacities. Sizes range from ¾ to 4 in. bore, and boundary dimensions conform to standard AFBMA series NAA and NAB. Bearings may be applied directly to hardened and ground shafts or used with



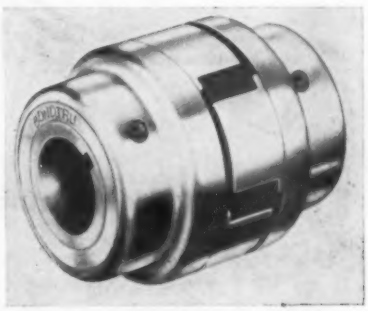
inner rings. They are interchangeable with needle bearings made to the same standards.

The Torrington Co., Torrington, Conn.

Circle number 208 on reader service card

Aluminum couplings

Bondtru flexible insulated line for light-duty applications. Six sizes with



20 standard bores from ¼ to 1½ in. Up to 10 hp at 1800 rpm is handled. Non-corrosive, self-aligning and need no lubrication.

Charles Bond Co., Philadelphia, Pa.

Circle number 209 on reader service card

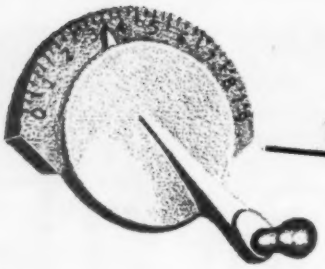
Torque control

Electro-mechanical control protects critical production and testing operations involving torque. It makes accurate torque measurements, automatically shutting off power equipment at a point slightly above normal work load. Can be used as an alarm in automatic production processes in which torque is produced by electric motor.

TippTronics, Inc. Chagrin Falls, Ohio.

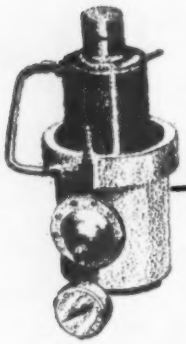
Circle number 210 on reader service card

Continued on page 29

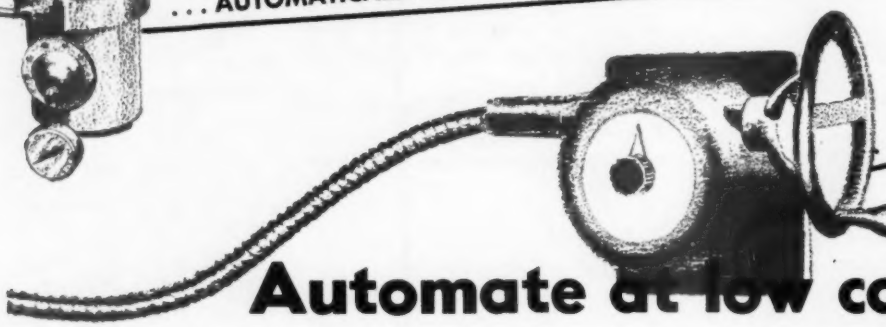


YOU CAN ADJUST SPEED MANUALLY

...BY PUSH BUTTON



...AUTOMATICALLY FROM INSTRUMENT SIGNAL

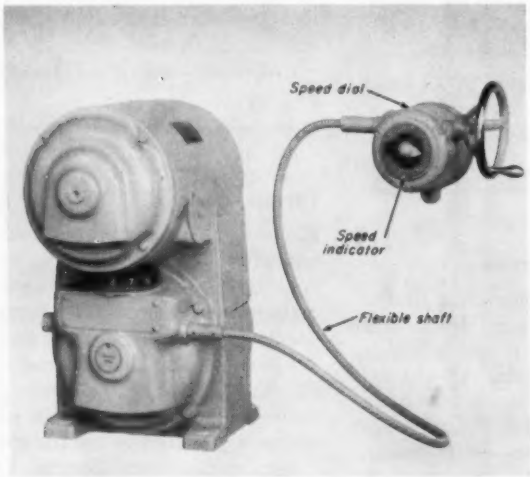


...OR REMOTELY

Automate at low cost with

Many different principles are used

Mechanical adjustable speed drives differ widely in operating principle. Some use gears to adjust speed, others use belts, chain, steel balls, tapered cones, linkages, springs, friction discs and other devices.



REMOTELY-CONTROLLED drive can be installed in congested area.

Drives also differ in methods of control. Some are controlled manually, others remote-manually, or automatically, or by semi-automatic push button control.

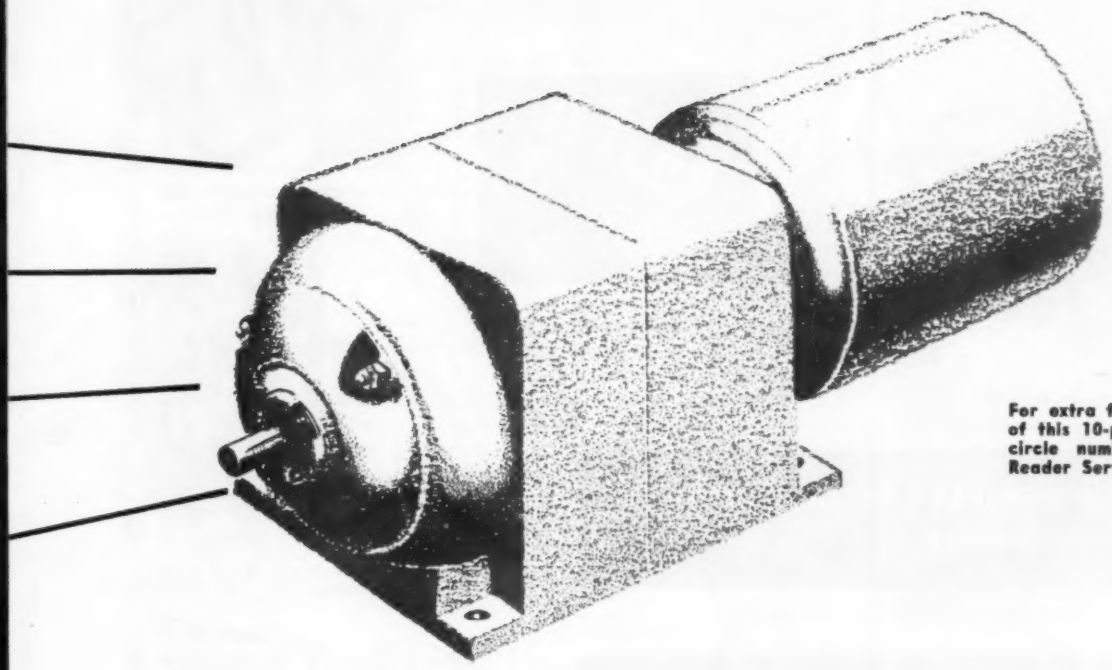
A typical manual control is a hand wheel or speed dial mounted on the drive housing. A typical remote-manual control is shown in the adjoining photograph. A typical automatic control is one in which an air cylinder or a solenoid adjusts the control shaft from instrument signals. No manual attention to the drive itself is needed. A push button control is usually mounted remotely from the drive on a pendant or in a control console.

Drives are either stepped or stepless; limited or infinite in range and speed. Stepped means that speed is changed from one fixed speed to another in increments —a four-speed gear box transmission is an example.

Stepless means that speed adjustment is smooth, without increments—two adjustable-pitch sheaves and belt are an example.

Limited speed range means that a drive can only operate in a fixed range between two speed limits—two adjustable sheaves and belt is again an example.

Infinite speed range means that the drive can operate over a full range from zero to maximum—a wheel and disc drive is an example.



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mechanical adjustable-speed drives

Many different types are available

SELECT AN ADJUSTABLE speed drive with care and you will get the kind of adjustable shaft speed you want, when you want it, at a low comparable cost.

If you need only to adjust speed slightly, every other month or so, try a simple adjustable-pitch pulley drive on which you can change pitch diameter by hand. This represents one of the least cost investments.

If you have to change speed slightly, but somewhat more frequently within the same general speed range, try a spring-loaded variable pulley and sliding motor base unit. You will be spending a few more dollars but it is still a very low cost drive.

And so on up the scale. You can get some type of mechanical drive for every job and every budget.

Overdesign, however, can be just as improper as sticking to an old-fashioned method of constant speed when you need adjustable speed.

Stepped Speed

There are many types of stepped speed drives. V, flat and other types of belts are used with stepped pulleys. Speed change is accomplished by shifting the

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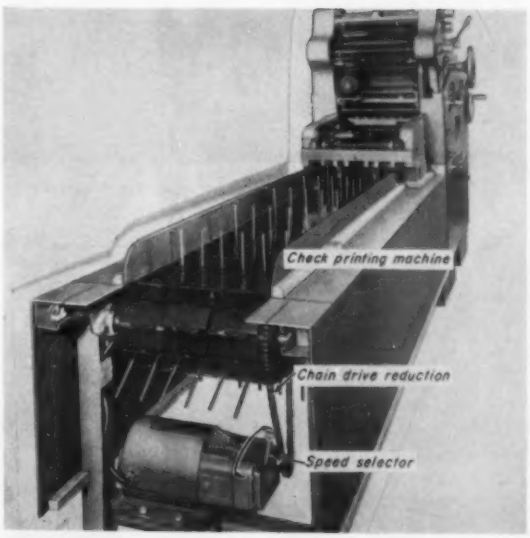
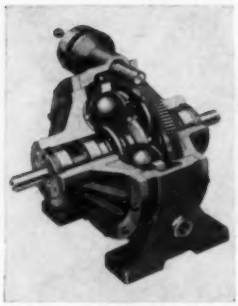
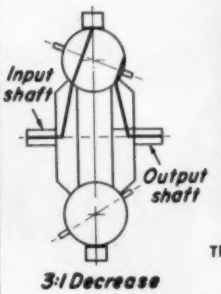
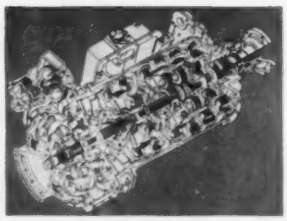


ABILITY TO ADJUST speed increases production efficiency of check printing machine. Drive has crank motion, drives output shaft in impulse fashion through series of one-way clutches.

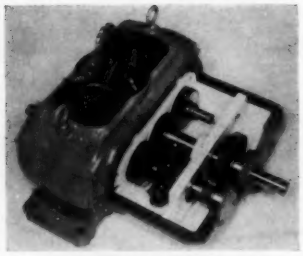


BALL SPEED VARIATOR

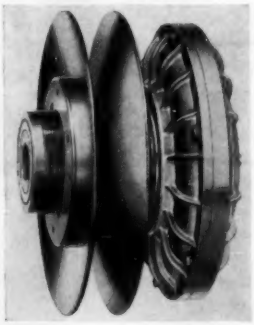




AUTOMATIC GEAR - TYPE TRANSMISSION FOR HEAVY VEHICLES

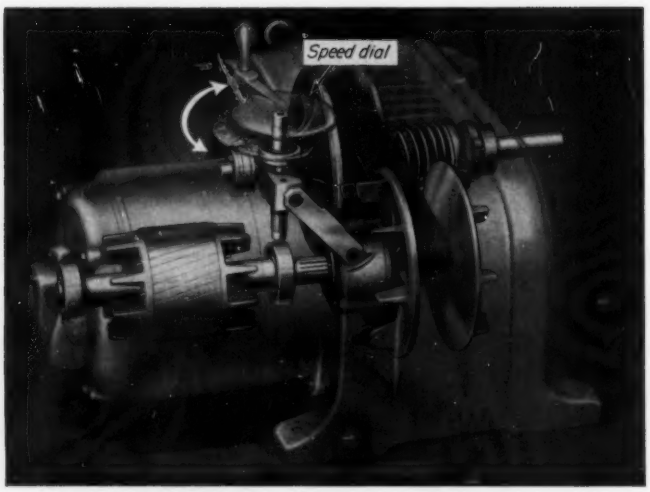


DIFFERENTIAL GEAR TYPE TRANSMISSIONS

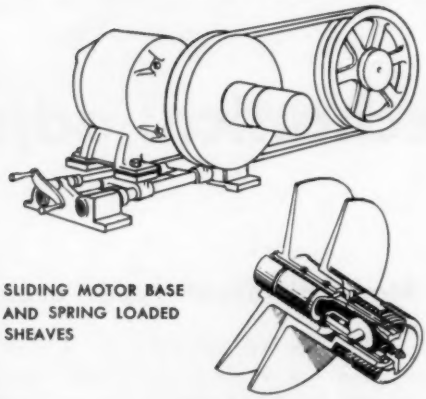


VARIABLE - PITCH SHEAVE INTEGRAL WITH FLUID COUPLING

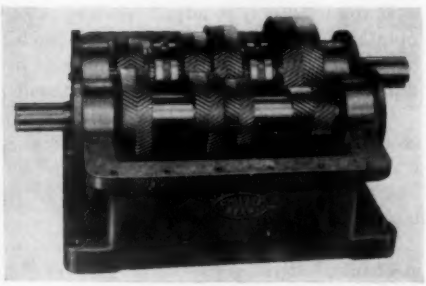
DIFFERENT PRINCIPLES OF OPERATION AND TYPES AVAILABLE



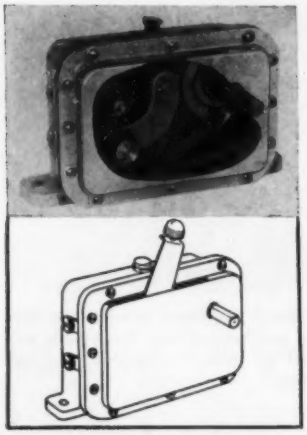
MANUALLY - CONTROLLED ADJUSTABLE SPEED DRIVE



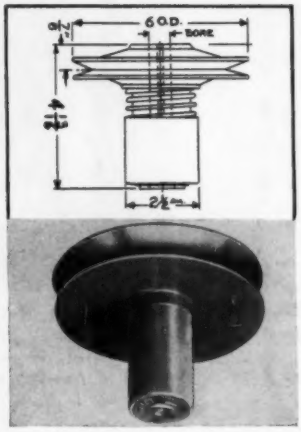
SLIDING MOTOR BASE AND SPRING LOADED SHEAVES



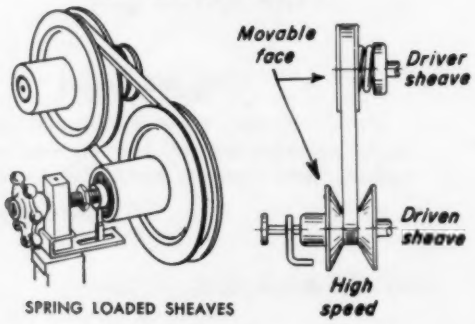
FOUR GEAR SETS WITH MANUAL OR ELECTRIC SHIFTING



CRANK MOTION THROUGH SERIES OF ONE - WAY CLUTCHES



VARIABLE SPEED PULLEYS



SPRING LOADED SHEAVES

belt to different steps on the pulleys, usually when the drive is stopped.

Contact-type pulleys are another type and are commonly seen on phonograph turntables. They have stepped diameters on the motor input shaft and turret pulleys of different diameters on the opposing shaft for speed adjustment.

Gear drives are the most popular of all stepped drives and represent the largest percentage of drives used in the country. They are marketed in all sizes and speeds from fractional to many thousand horsepower.

Gear drives can be purchased with manual, automatic, semi-automatic and electric shifting; with spur, helical, herringbone, and other types of gear teeth. They are made with parallel shafts, coaxial shafts, right angle shafts, multiple output shafts and others.

Shifting is accomplished by shifting gear sets to engage different gears; by electric clutches which do not move gear units but engage or disengage meshed gears; by fluid means, such as in the automobile automatic transmission and other less conventional ways.

Adjustable gear drives are very dependable for long years of service without maintenance.

Stepless Speed—Limited Range

Cone pulleys are analogous to step pulleys except that speed adjustment is done with a flat belt which can be shifted back and forth along pulleys that are shaped like a frustrum of a cone shape.

Variable-pitch sheaves provide speed adjustment as their faces separate to allow a belt or chain to ride at

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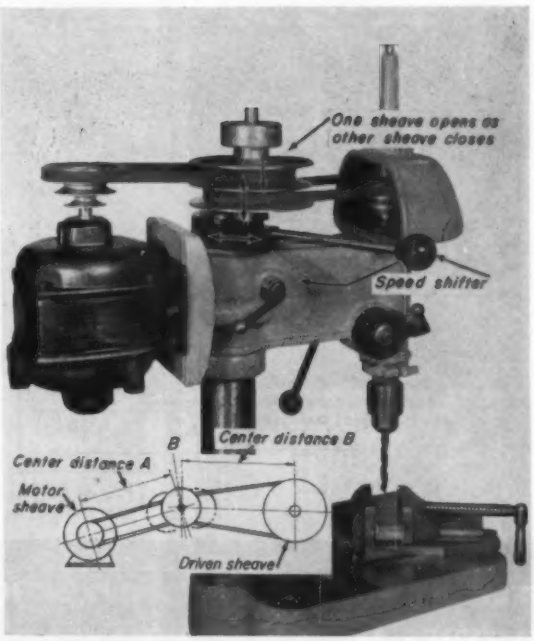
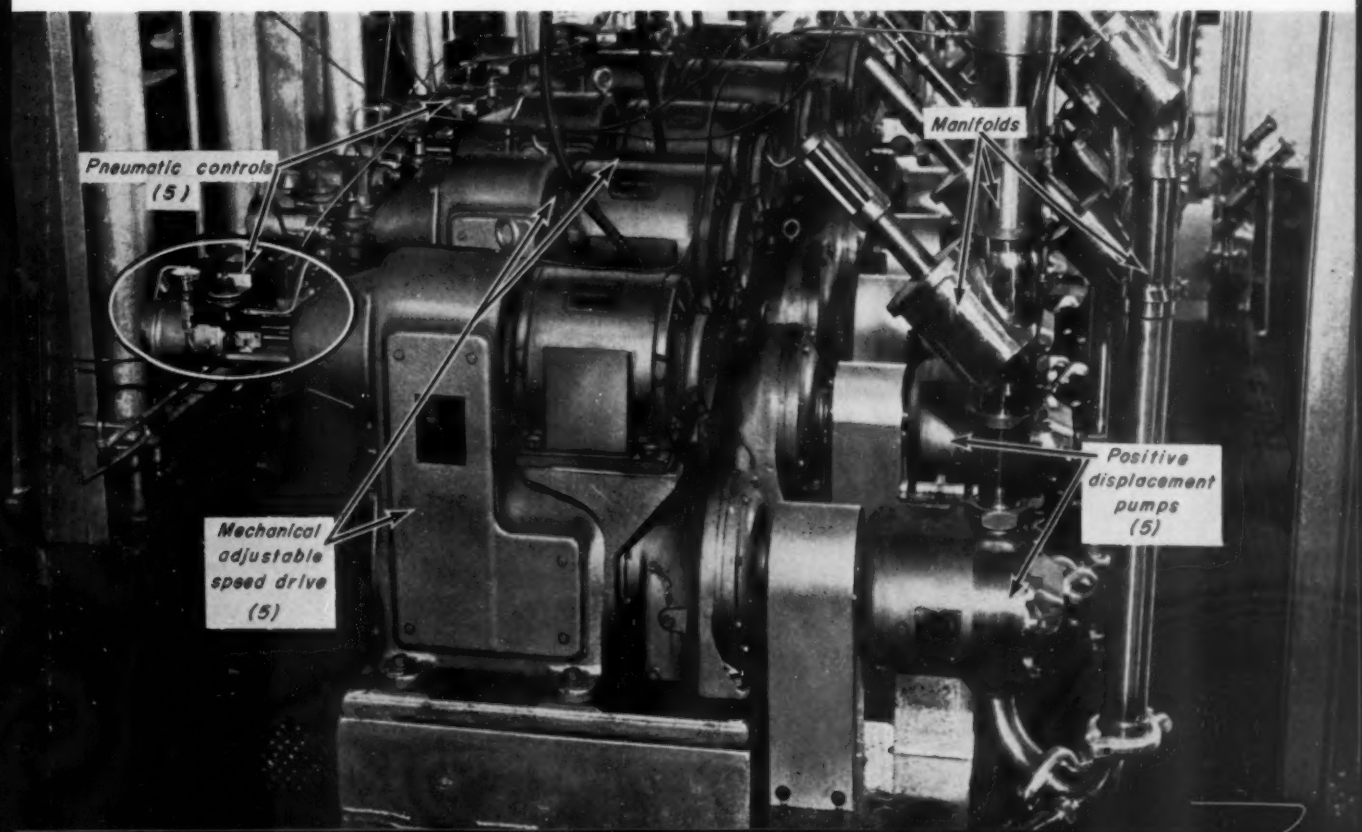
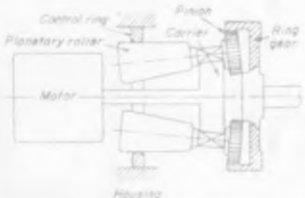


WIDE SPEED RANGE can be selected on drill press. Rotation of shifter handle causes one sheave to open and other to close changing speed. Manual selection of fixed sheaves gives different ranges.

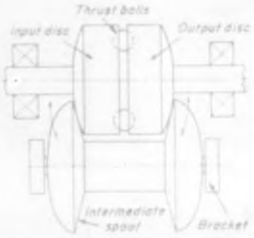
BATTERY OF DRIVES with automatic pneumatic controls power series of pumps in fruit canning plant. As water evaporates from fruit, pressure signals change (3 to 15 psi) and adjust drive speed accordingly.



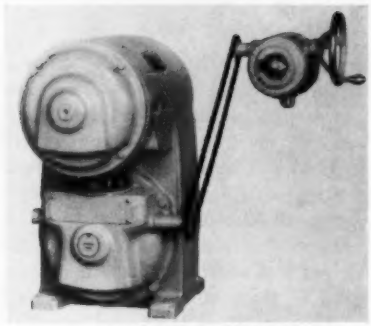
MINIATURE ADJUSTABLE
RATIO SPEED CHANGER



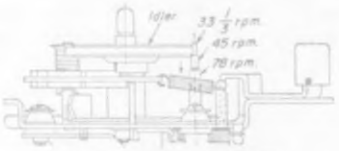
METAL TRACTION SYSTEM



THRUST BALL FRICTION UNIT



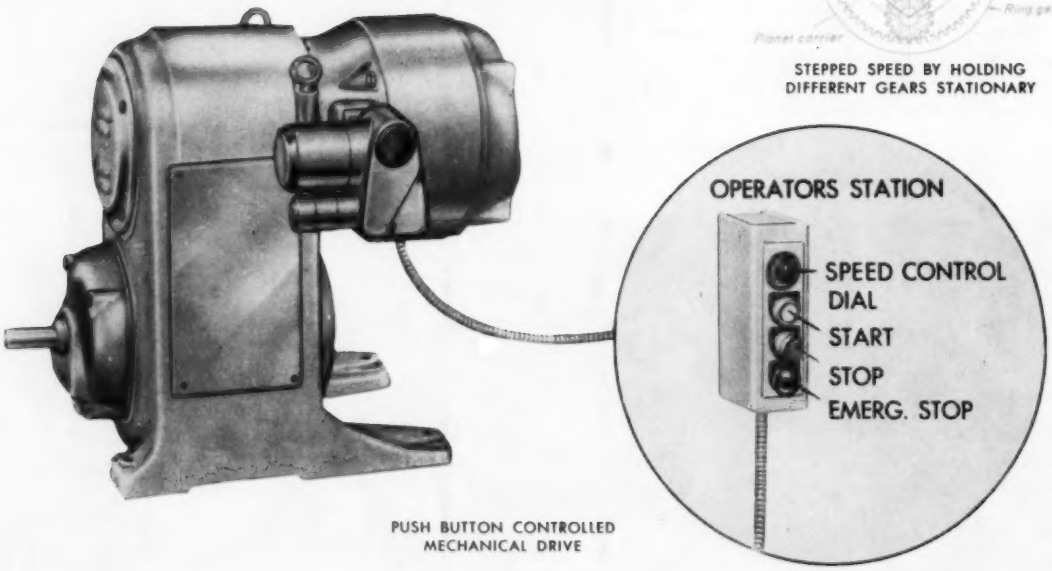
CHAIN AND SPROCKET
WITH HANDWHEEL INDICATOR



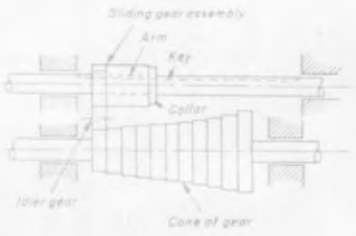
STEPPED SHAFT DIAMETERS

DIFFERENT PRINCIPLES OF OPERATION AND TYPES AVAILABLE

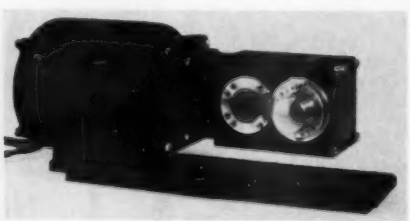
STEPPED SPEED BY HOLDING
DIFFERENT GEARS STATIONARY

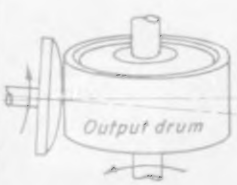


PUSH BUTTON CONTROLLED
MECHANICAL DRIVE



STEPPED CONE GEARS





INFINITELY - VARIABLE FROM ZERO TO FULL SPEED

different pitch diameters. In some cases the sheaves are externally-controlled to open and close proportionally to a dial setting. In other cases, spring load is applied to the movable face to permit adjustment to different torque requirements by a screw-down device.

Sliding and adjustable motor bases are frequently used with adjustable sheaves. Compound sheaves, with more than one sheave unit on the same shaft, give wide speed ranges.

Special reinforced ribbed, staked, jointed and coupled belts and chain are used by many manufacturers. Some units are designed for high horsepower to operate for long periods without maintenance; others for low horsepower and speed.

Metal traction drives, ball variator and *variable stroke* drives are also of this type.

Stepless Speed—Infinite Range

A *differential transmission* is one of this type and usually has a bevel gear or other type of right angle ratio device incorporated with an adjustable speed changer.

Planetary V-belt units are another. They are built similarly to planetary gear sets except with sun and planetary sheaves. One of the sun sheaves is held stationary and the other is mounted rigidly to rotate with the output shaft. The planet carrier is the input member and as the planetary sheaves revolve around the central axis, they also rotate about their own axis producing a differential action. Output speed is a function of the difference in ratio of the two belts.

Wheel and disc, metallic traction, and *variable stroke impulse* drives are also of this type.

Compound Planetary Gear Principle

This principle is used on drives from fractional hp up. It is generally contained in a gear box attached

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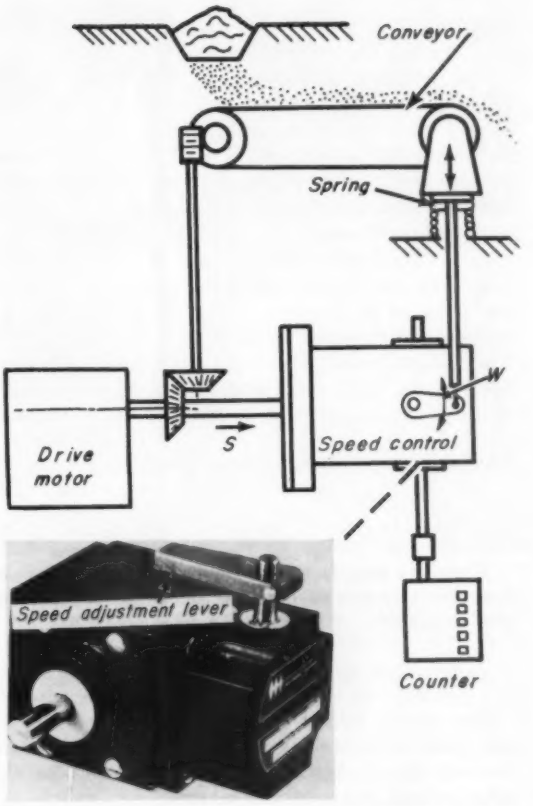
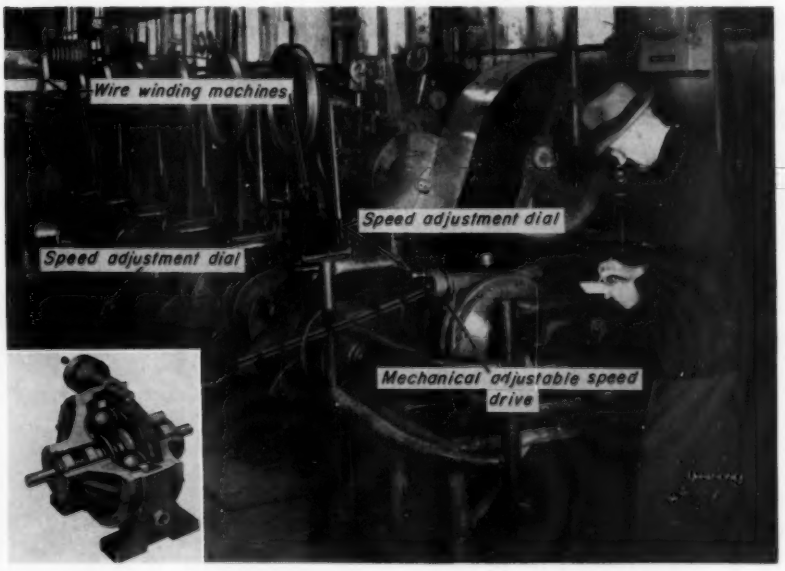


CONVEYOR SPEED is controlled as function of material weight passing over outboard end of belt. Linkage oscillates to adjust speed. Drive acts as speed controller.



PRODUCTION SCHEDULES of wire winding machines are adjusted when needed by adjusting speed dial. Ball variator-type drive provides variable speed selection through 9:1 range.

integrally with an a-c induction motor with the speed control dial on the housing.

The input shaft supports a carrier for tapered rollers. The tapered rollers are inclined at an angle equal to their taper so that their outer edge is maintained parallel to the central axis. Traction pressure between the tapered rollers and traction ring is obtained by centrifugal force of the rollers pressing outward against the traction ring under centrifugal force.

In a typical drive with a ratio of 3 to 1 between ring gear and pinion, maximum speed is obtained with ring at the big end of the roller. The ratio of control ring diameter to roller diameter is, say, 6 to 2.5. Output speed, then—the ring gear speed—is equal to the input speed reduced by the roller speed about their own centers divided by the gear ratio

$$\text{Maximum output speed} = \text{input speed}\left[1 - \frac{6/2.5}{3}\right] = \frac{\text{input speed}}{5}$$

When the ring is moved towards the small end of the roller to a point where the roller diameter is 2 in. ring diameter and gear ratio being fixed

$$\text{Zero output speed} = \text{input speed}\left[1 - \frac{6/2}{3}\right] = 0$$

Zero speed will always occur when the control ring contacts the rollers at the point where the ratio between ring and roller diameters is equal to the ratio between ring gear and pinions.

When the ring is moved fully to the small end of the roller the contact is at a roller diameter of 1.67 in.

$$\text{Reverse output speed} = \text{input speed}\left[1 - \frac{6/1.67}{3}\right] = \frac{\text{input speed}}{5}$$

Toroid Disc

Drives of this type consist of two toroid shaped discs coupled to two shafts and two rollers which transmit rotation between the discs. The rollers are mounted in adjustable gimbals so that they contact the discs at equal but variable radii from the center of the disc.

Ratio of speeds between the two discs is continuously variable as the gimbals are rotated. The discs are not attached to the shafts but are torsion-coupled to them by means of ball bearing crown-type cam sets which press the discs inward against the drive rollers with a force proportional to the torque transmitted.

The sloping surfaces of the cams are such that contact pressure is always more than sufficient to prevent ordinary slippage within the operating range of the cams. Roller contact pressure is supplied by the cams only as needed, insuring free running and maximum life with light loads.

Wheel and Disc

Generally these are available in fractional hp models. Driving mechanism has a cupped disc engaging a cylindrical drum. Tilting of the disc causes the disc and drum to engage at different driving diameters of the disc, which changes speed.

Efficiency is between 85% and 95%. Range is infinitely variable from zero to full speed in either direction.

Drive may be operated continuously at zero speed. There is no wear on the disc if the output speed is zero.

Input torque goes from zero at zero position to full torque at full speed. Output torque is approximately constant and may be adjusted.

Resolution is continuous, with no lost motion in control. There is no possibility of hunt or instability

Mechanical adjustable speed drive manufacturers*

Allis-Chalmers Manufacturing Co.
Allison Div.
General Motors Corp.
American Pulley Co.
Bendix Aviation Corp.
Borg-Warner
J. D. Christian Engineers
Cleveland Worm & Gear Co.
Crofts U.S.A., Inc.
De Laval Steam Turbine Co.
Dodge Manufacturing Corp.
Foote Brothers Gear & Machine Corp.
Funk Manufacturing Co.
General Electric Co.
General Industries Co.
Gerbing Manufacturing Corp.
Graham Transmission, Inc.
Horton Manufacturing Co., Inc.
Humphrey, Inc.
International Harvester Co.
Lewellen Manufacturing Co.
Lima Electric Co.
Link Belt Co.
Lovejoy Flexible Coupling Co.
Maurey Manufacturing Corp.
Mentor Products Inc.
Metron Instrument Co.
Morse Chain Co.
The National Supply Co.
Philadelphia Gear Corp.
Reeves Pulley Co., Div. Reliance Electric & Engineering Co.
Rockwell-Standard Corp.
Servo-Tek Products Co.
Simplatrol Products Corp.
Snow-Nabstedt Gear Corp.
Speed Selector Inc.
Sterling Electric Motors, Inc.
Stratos Div. Fairchild Engine & Airplane Corp.
Thompson Ramo Woolridge Inc.
Turner Transmissions Inc.
U. S. Electrical Motors, Inc.
Wagner Electric Corp.
Western Manufacturing Co.
Western Gear Corp.
Westinghouse Electric Co.
T. B. Wood's Sons Co.
Worthington Corp.
The Zero-Max Co.

*Responding to our questionnaire

since driving is continuous and ratio is infinitely variable.

Roll Chain

Adjustable speed is accomplished with one or more loops of roll chain engaged in several adjustable-pitch, wheel-type pulleys. The chain has high load carrying capacity and has an ability to operate at high speed.

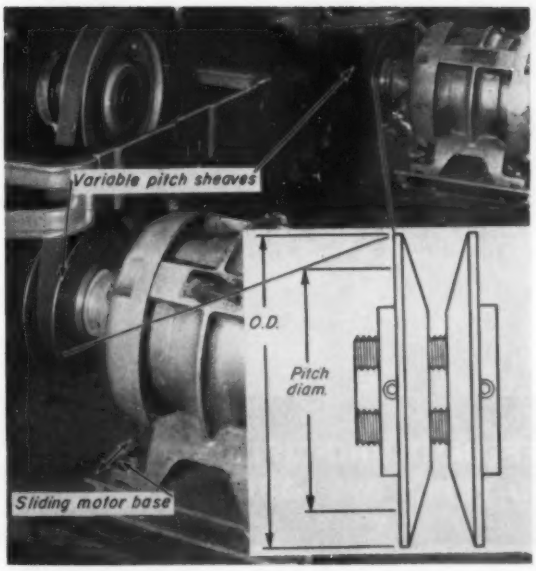
Each pitch of chain consists of a center member with a hardened and ground roller section. Rollers are mounted so they can rotate laterally with respect to the center member. Pressure acting on the chain at each pair of wheel faces transmits the power to the center member through the externally mounted rollers. Chain pull is transmitted by each center member in a continuous looping arrangement. The center members also act to receive the external roll pressures during wheel face engagement. Short pitch design assures smooth chain meshing action and distribution of load over a greater number of contact areas.

Self-Tooth-Forming Chain

This type has a heavy duty chain that operates in adjustable pitch, radially-grooved wheels. Changing of pitch causes the chain to ride up or down the wheel faces which changes speed.

The teeth of the wheels are cut at a constant depth but are of increasing width toward the periphery. The sides of the teeth are beveled which provides gripping areas for the chain slat members during engagement. The chain slats shuffle back and forth between the wheels and mesh fully when they engage.

The chain is made from a series of overlapping steel links with joints consisting of hardened steel



ROW AFTER ROW of spinning frames in textile mill have adjustable pitch sheaves and sliding motor bases. Speed can be varied by screwing movable flange in or out and locking in place; and adjusting motor base.

pins and bushings. The links contain packs of hardened steel laminations or slats which are free to move transversely from side to side, singly or collectively in relation to one another, to serve as teeth on the drive chain.

The easy sliding movement of the slats is a dominant factor in securing the positive engagement of the chain. All tooth action is positive over the full range

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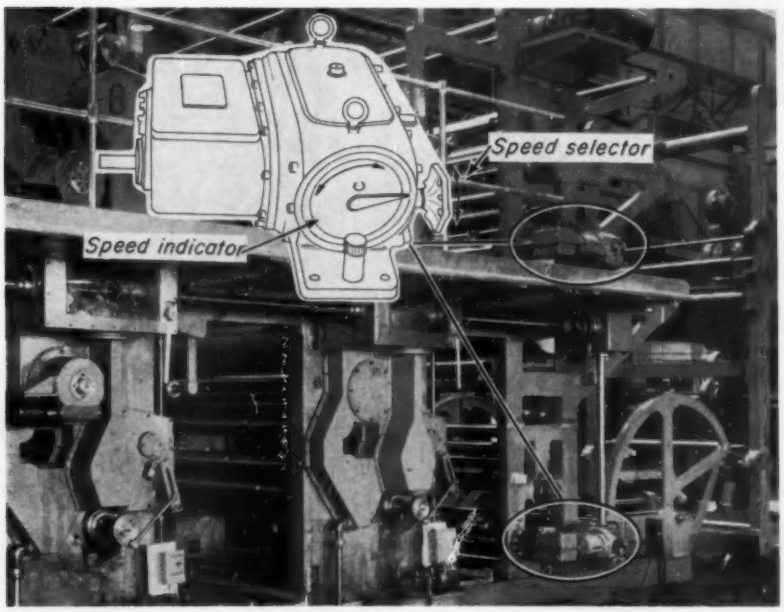
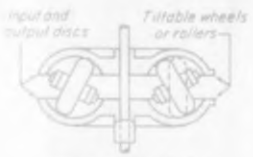
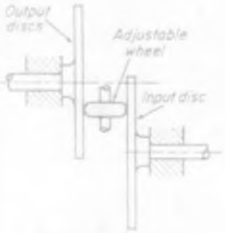


TWO VARIABLE SPEED transmissions provide minute ratio accuracy and close tension control for paper advancing in multi-color printing press.

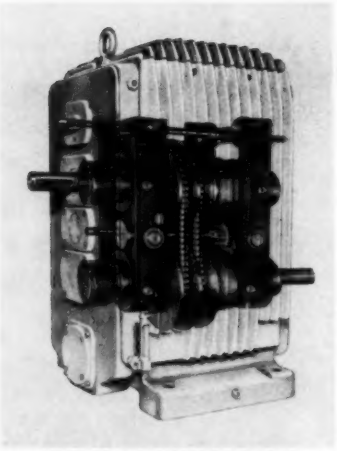


METALLIC TRACTION PRINCIPLE

STEPPED PULLEY SYSTEM

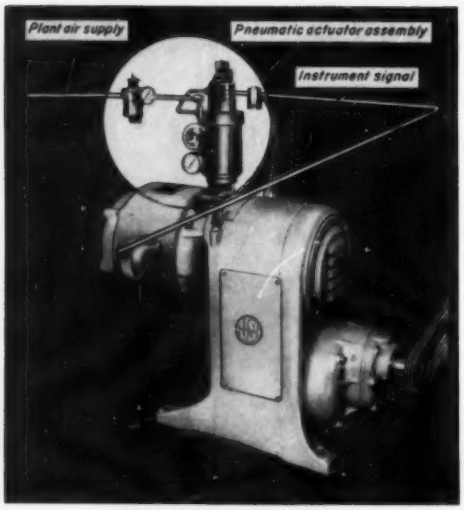


WHEEL AND DISC SYSTEM

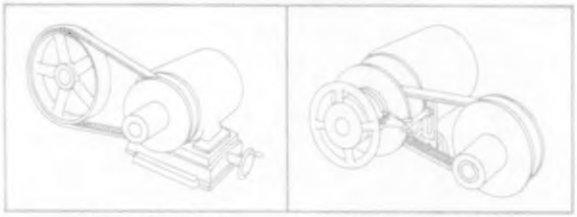


ROLL CHAIN ON ADJUSTABLE WHEEL DISCS FOR RUGGED DUTY

DIFFERENT PRINCIPLES OF OPERATION AND TYPES AVAILABLE

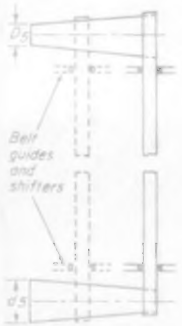


AUTOMATICALLY - CONTROLLED FROM INSTRUMENT SIGNAL

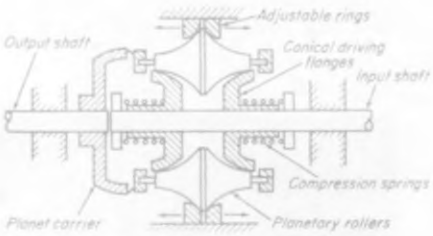


SLIDING MOTOR BASE

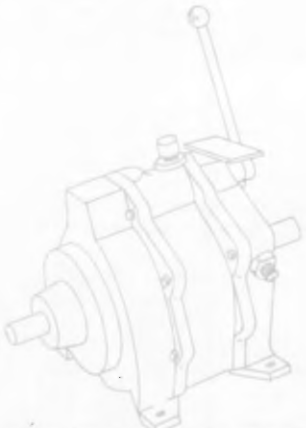
ADJUSTABLE SHEAVES



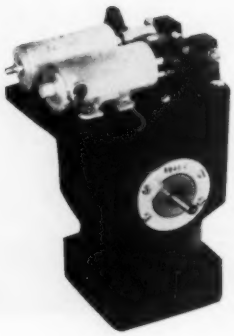
CONE PULLEY SYSTEM



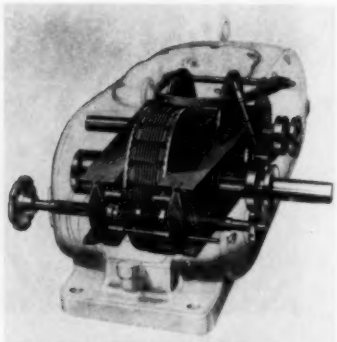
PLANETARY METALLIC - TRACTION TYPE



REVERSING TRANSMISSION WITH TWO SPEED FORWARD AND REVERSE



SOLENOID OPERATED



ADJUSTABLE PITCH CHAIN WITH SELF - FORMING METAL TEETH

of operating wheel diameters. Slippage, which would cause fluctuations, or steps in speed, is eliminated.

Impulse

This type uses a crank motion of the input shaft to create linear motion which drives the output shaft through a series of one-way motions. A leverage mechanism between the two shafts varies the length of stroke which results in stepless output speed from zero rpm to ¼th motor or input speed. Speed can be changed running or stopped and can be changed rapidly and frequently by moving a lever. Torque is usually constant through the speed range.

As an example of operation, with 1750 rpm input, output motion consists of several hundred urgings per second. Output is smooth and continuous for practical purposes. With constant input and load, speed holds well and will repeat on resetting. Drive does not wear-in at one setting regardless of how long it runs before speed is changed.

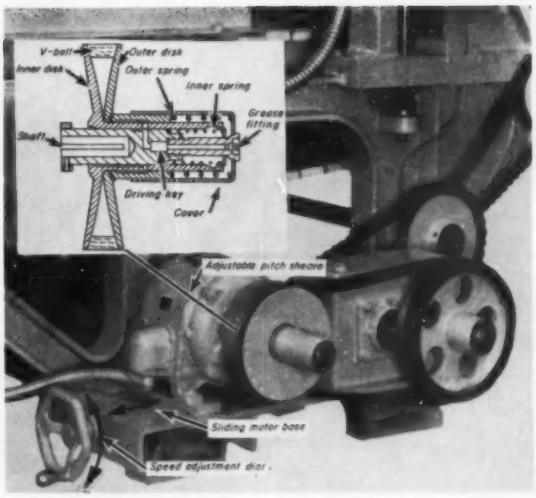
Ball-variator

This principle is used generally on heavy duty drives. Power is transmitted through an input shaft to a beveled drive disc in nominal pressure contact with axle-mounted drive balls. Rotation of the input shaft causes the balls to rotate about their axles.

A similar drive disc on the output shaft of the unit is in contact with the drive balls and is, in turn, rotated by the balls, thus driving the output shaft. If the input shaft is presumed to run at a fixed speed, the speed of the output shaft is determined by the angular positioning of the axles on which the drive balls rotate.

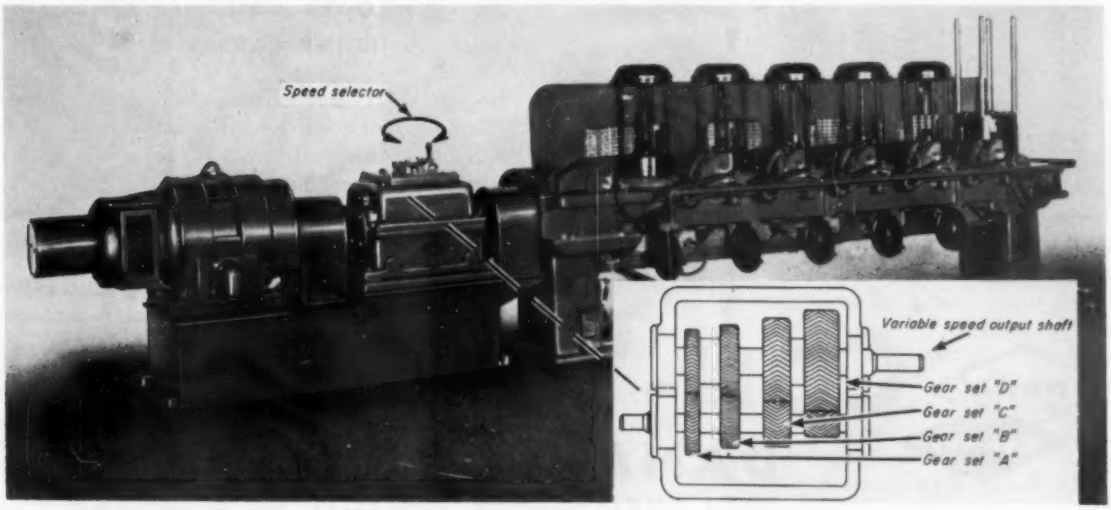
With the ball axles parallel to the drive shafts, speed ratio between the drive shafts is 1:1. However, the ball axles can be tilted uniformly in either direction to a common point of intersection of their axes so that the effective rolling radii of the balls with the engaging discs have a ratio variable up to 3:1.

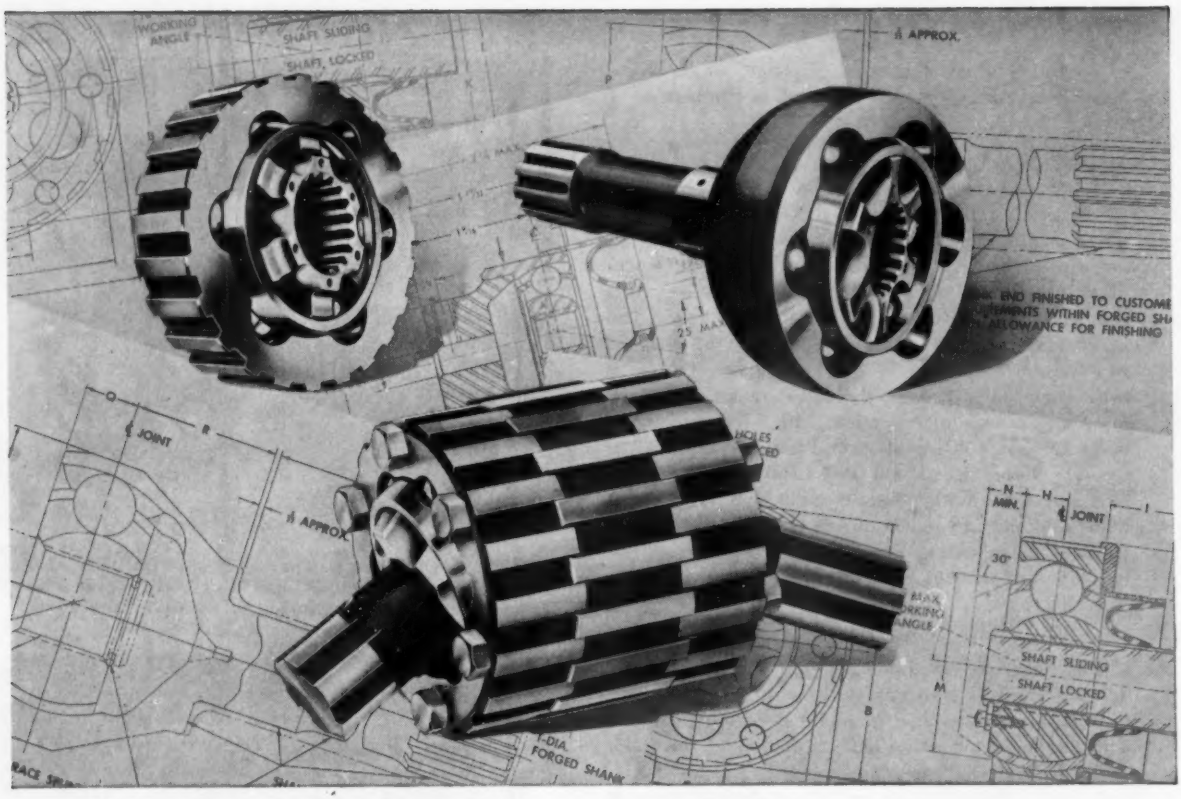
This adjustment is made by the angular positioning of a cam-slotted plate through which the ball axles project. The ends of the ball axles fit into radial slots in the end covers of the unit which prevent the balls from revolving about the drive shafts. Close control of speed adjustment is obtained by employing a worm drive to position the speed-regulating plate. The adjusting worm can be operated through remote, manual or automatic devices. ▲▲▲



RIP SAW DRIVE has spring-loaded variable-pitch sheave and sliding motor base. Rotation of speed dial causes belt pull against spring to adjust to new speed setting.

HEAVY-DUTY FOUR-SPEED gear box drives wire drawing machine at 925, 1045 and 1670 rpm from motor speed of 1750 rpm. Speeds are selected manually. Drive holds 15½ gallons of oil and lasts lifetime of machine.





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New Con-Vel Division To Produce Famed Constant Velocity Universal Joints—With These Advantages To You:

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Rzeppa universal joints provide perfectly smooth torque all the time, every time, even at angles up to 35°! Rzeppa rules out bounce, chatter, vibration by keeping the hardened steel driving ball bearings in the correct bisecting plane, no matter what the shaft angle may be. The smoother, constant velocity performance of Rzeppa joints naturally increases shaft and bearing life; adds to over-all efficiency and economy of operation.

Rzeppa universal joints are available in a wide variety of sizes, angles, speeds and styles . . . designed for front drives, articulating axles, propeller shafts, and scores of special applications. For information on their many advantages write to—

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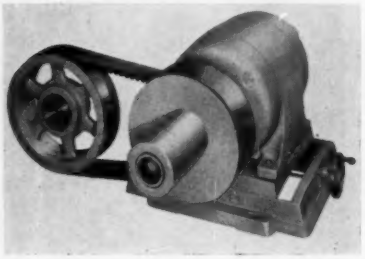
CON-VEL DIVISION
DANA CORPORATION
3901 CHRISTOPHER, DETROIT 11, MICHIGAN

For more information Circle No. 31 on Reader Service Card

CONTINUED from page 17

Variable-speed pulleys

New, compact design, 20- and 25-hp variable-speed drives permit infinite speed adjustments while in operation. They offer 3 to 1 speed range. 414 and 414/25 variable pulleys have been developed and tested for the drives. Other components include



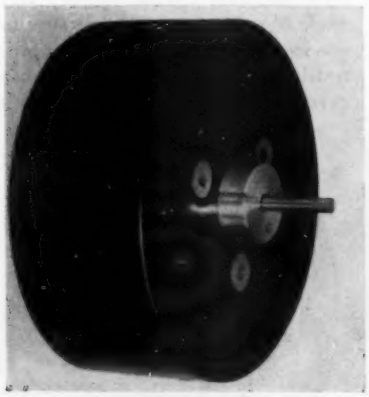
long-life 414 variable belt, a 412 adjustable base for 324U and 364 frame motors, plus a selection of controlling devices and a wide choice of sheaves.

Lewellen Mfg. Co., Columbus, Ind.

Circle number 211 on reader service card

Hysteresis motors

Synchronous electric motors for high-precision applications. Motor-induced flutter will not exceed 0.1 rms at 1200 rpm or 0.15 rms at 360 rpm. Models will withstand tempera-



ture ambients from —32 to 135 deg C, and are insensitive to power supply voltage variations. Specially suitable for tape transports, turntable drives, missile and aircraft uses, computer drum drives and dynamometers.

Hysyn Electromotive, Telecomputing Corp., Los Angeles, Calif.

Circle number 212 on reader service card

Available November 25th

Complete Guide to hydraulic and pneumatic design.

This 1024 page volume includes:

- 304 page design section of circuits, nomographs, application data.
- Index to 600 manufacturers of everything from accumulators to wiper rings.
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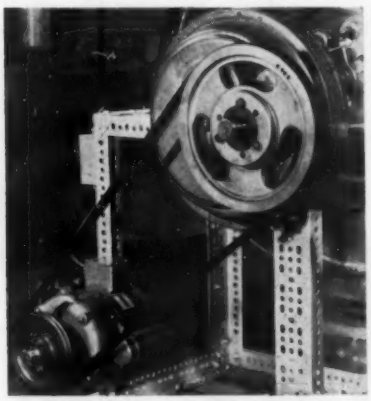
Compiled by the editors of
APPLIED **Hydraulics & Pneumatics**
812 HURON RD., CLEVELAND 15, OHIO

V-belt drives

New drives, called American 3-5-8, use improved V-belts with cross-sectional areas reduced nearly 50 percent. Up to 3 times as much power can be transmitted in same area, or fewer belts, narrower sheaves and smaller center distances may transmit



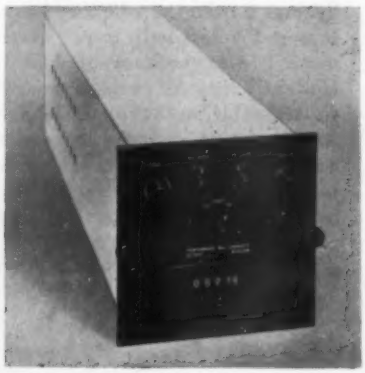
the same amount of power. Hp ranges are: 3V, 1 to 50; 5V, to 200; 8V, to 1500 hp.

American Pulley Co., Philadelphia, Pa.

Circle number 213 on reader service card

Digital torque indicator

Model 756TA takes fluctuating torque readings from equipment on



test and integrates them into a true average. Special filter network compensates for power output variation inherent in most rotating equipment. With four number wheels, unit gives readability of one part in 10,000, with accuracy of ±0.1 percent.

Performance Measurements Co., Detroit, Mich.

Circle number 214 on reader service card

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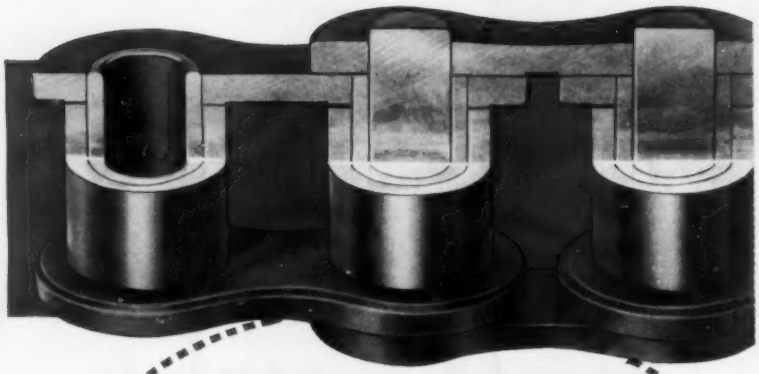
MAXIMUM WEARING SURFACES *for longer chain life*



ACME'S SECRET
for years of additional service

Special hardening of pins, bushings and rollers help insure maximum life expectancy of ACME Roller Chains. All parts subjective to articulation have glass-hard wear-resistant surfaces to render eminent life expectancy. The side plates or links which act as connecting members for articulating parts are specially heat treated and tempered to insure great strength and ductility.

Maximum hardening of all wearing surfaces on ACME Chains is conducive to longer life, resulting in greater economy and lower maintenance cost.

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Write Dept. 28-G for new 100-page illustrated technical catalog including new engineering section showing 36 methods of chain adjustments.

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CONTINUED *from preceding page*

Expanded reducer line

Torque-Arm shaft-mounted speed reducer line now includes a 25 to 1 double reduction series in eight sizes.

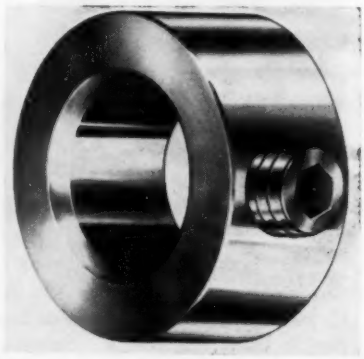
Output speeds range from 12 to 400 rpm. Line as a whole includes 8 sizes with torque arms in 15 to 1 or 25 to 1 ratios, along with three flange-mounted reducers. 5 to 1 single reduction Torque-Arms are also available.

Dodge Mfg. Corp., Mishawaka, Ind.

Circle number 215 on reader service card

Shaft collars

Non-corroding precision shaft collars made of cold-drawn stainless steel for service in chemical, electronic, food, textile and other applications where corrosion-failure of carbon steel is



dangerous. Precision-bored in thirty-one bore sizes, 1/8 to 2-1/8 in.

Climax Metal Products Co., Cleveland, Ohio.

Circle number 216 on reader service card

Continued on page 42

DESIGN
IDEAS
FROM THE FIELD

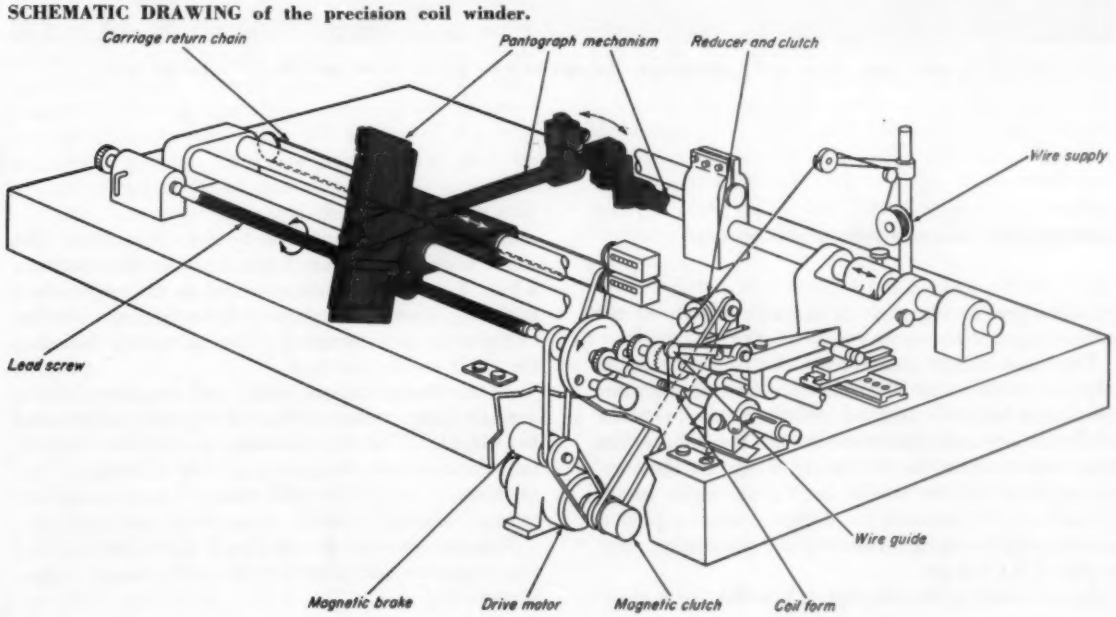
Pantograph magnifies leadscrew accuracy

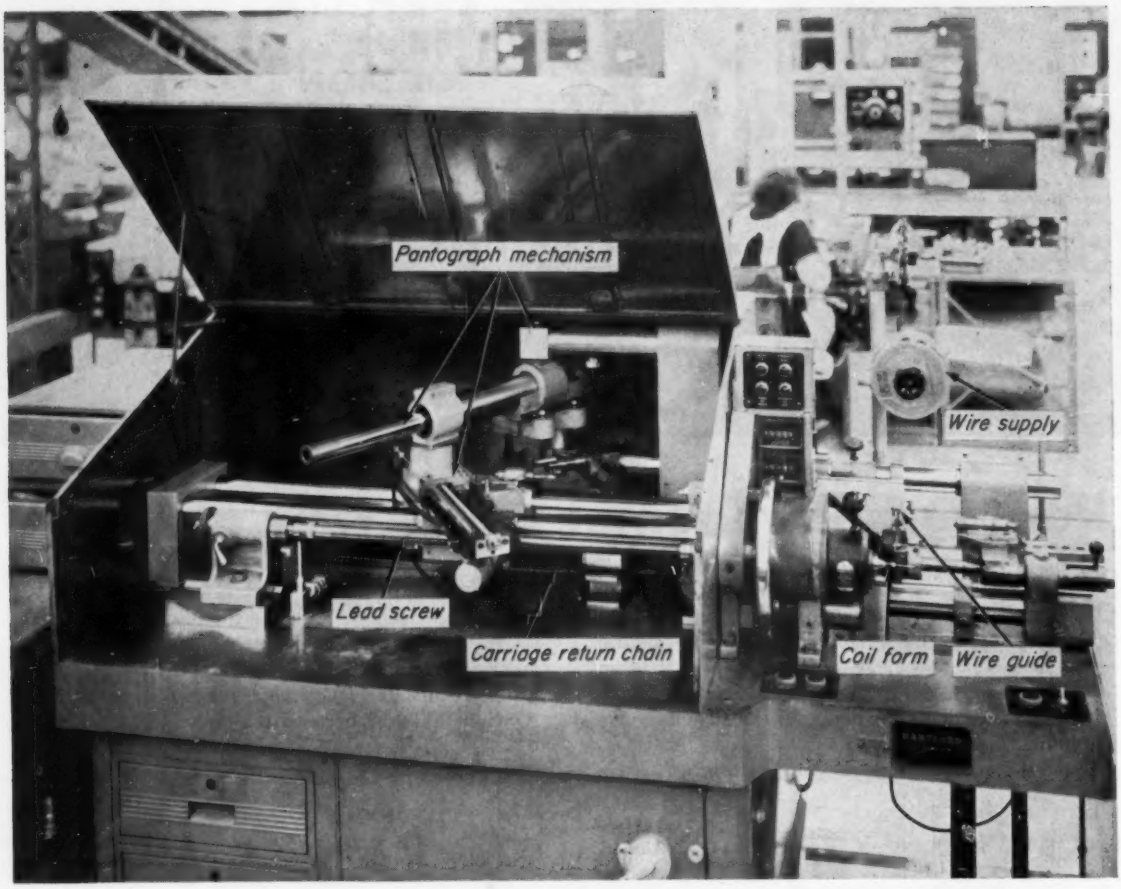
PRECISE SPACING and winding of wire onto the coilform of a precise winding machine is obtained with a leadscrew and pantograph mechanism. The extremely high degree of precision is obtained by magnifying the accuracy of the leadscrew through the pantograph linkage.

A dc drive motor supplied by a rectifier system powers the machine. It drives the lead screw through two belt reductions to give maximum screw speed of 1000 rpm from the motor speed of 1725 rpm. Speed is infinitely variable from the maximum down to zero. A magnetic brake between the motor and lead screw

Continued on next page

SCHEMATIC DRAWING of the precision coil winder.





COIL WINDER with lead screw and pantograph linkage to wire guide winds consistently accurate coils.

PANTOGRAPH *continued from preceding page*

provides precise stopping. A magnetic clutch on the motor output shaft engages or disengages the motor.

The same motor also rotates the coilform as the wire is wound on it. The coilform turns at the same rate as the leadscrew. As the coilform rotates, rotation of the leadscrew is translated through the linkage into linear movement of the wire guide to regulate the number of turns of wire wound onto a particular length of coilform. Adjustments for different winding pitches are made by changing leadscrews and by shifting pivot points of the linkage.

Rapid return of the carriage is provided by a chain and sprocket drive operated by the same motor. The chain is driven by a small speed reducer driven from a belt. A magnetic clutch mounted on the output shaft of the speed reducer engages to drive the chain. Motion of the chain is transmitted to the carriage by fastening the chain to the carriage.

As an example of consistency and accuracy, there is a single layer coil consisting of 14 turns which must be wound to have inductance of 0.0874 $\pm$0.0009 microhenries at a frequency of 100 kilocycles. This tolerance is $\pm$1%. The coils are consistently produced to tolerances of $\pm$0.0003 microhenries, or $\pm$0.35%.

This machine was designed by *Western Electric Co., Inc.* engineers and is used at their Merrimack Valley Works.

Mag-amp drive points Atlas skyward

INSTALLATION for launching Atlas missiles in concrete pit. Missile is kept in readiness in horizontal position. Erector raises missile for launching.

FEEDBACK TACHOMETER-TYPE magamp speed regulator with saturable reactors controls the drive motor of the Atlas missile erection mechanism. With overhauling loads, when weight of missile and boom passes overcenter, the control reverses phase sequence to produce torque opposing the motion of the system due to gravity. Thus, the drive always presents a positive load to the ac power supply.

Precise control, despite variations in direction and magnitude of load, is needed. The missile weighs 20,000 lb, and is approximately 80 ft long and 10 ft in diameter.

The boom is pivoted in such a way that horizontal movement of the carriage produces boom and missile elevation.

The drive motor is a 75-hp, explosion-resistant, high pullout torque, crane-type, wound-rotor induction motor. It drives the carriage through a 234:1 triple reduction reducer, floating shafts, and chain and sprockets. Chains are 90 ft long, 2½ in. pitch, triple-strand.

Acceleration of the drive motor from rest to operating speed takes 3 to 5 sec. There are no abrupt torque peaks during acceleration or deceleration. Design limits maximum rate to 0.1 radian per second per second. Speed regulation is constant within ±5% at normal speeds and ±2.5% at creep speeds of 85 rpm and lower. The system maintains these speed regulation and acceleration values under all load conditions.

A magnetic disc brake connected to the input shaft of the speed reducer is used for stopping and holding the system. The brake operates on 440 v ac. Electrical interlock automatically releases the brake when the motor is energized. Brake actuation does not impose deceleration rates higher than the 0.1 rad per sec per sec.

Tachometer generator is roller-chain driven from the motor with a 1.2:1 ratio. It operates in the saturated region of its response curve to minimize variations in output due to fluctuating line voltage.

A slow-down check circuit checks the tachometer signal at a predetermined interval after the *fast* signal is interrupted. If slow down is not being accomplished, it will *emergency stop* the drive. This system will stop the drive from full speed before the limit of travel is reached.

To compensate for wear, minimize shock loading

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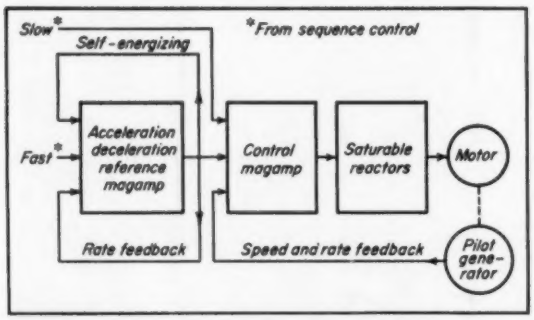
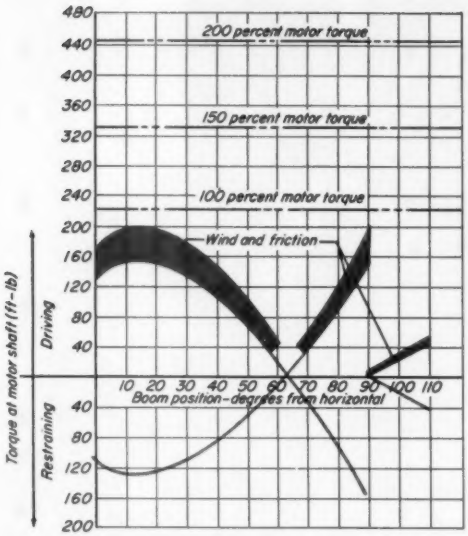
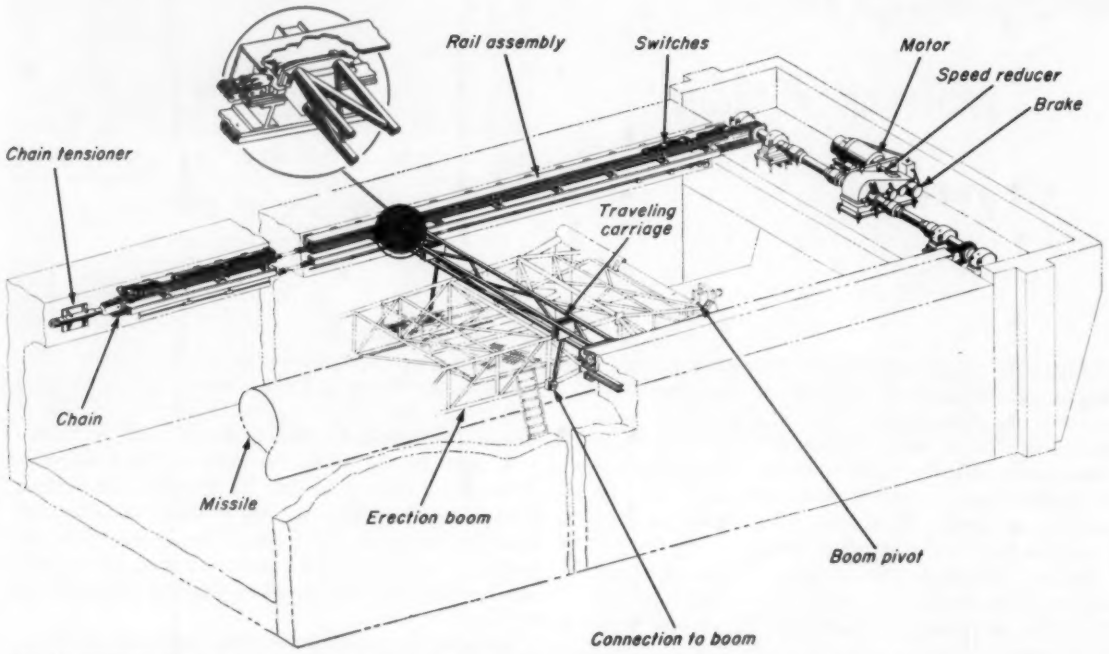


ELECTRICAL CONTROL SYSTEM block diagram



DRIVE TORQUE REQUIREMENTS for raising and lowering missile and boom.



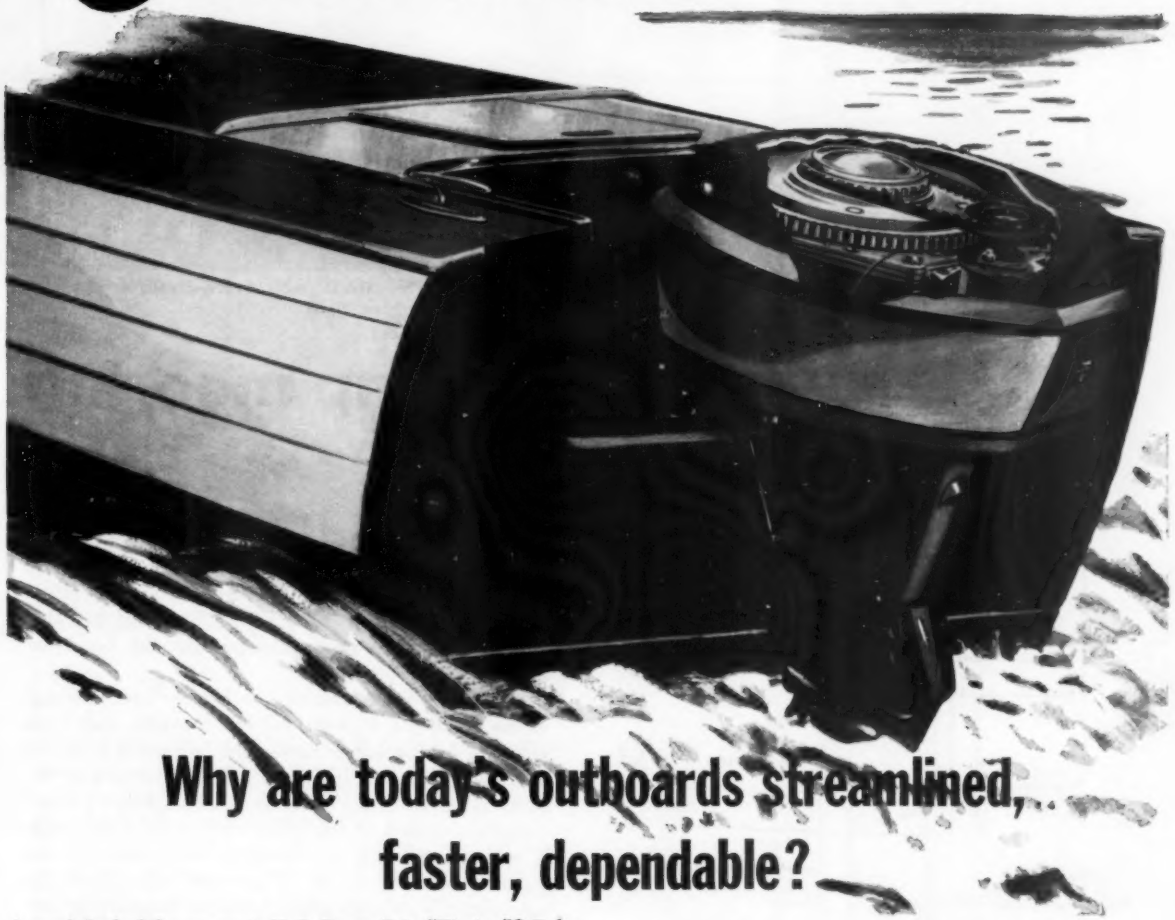
ATLAS ERECTOR. Back and forth motion of carriage causes boom and missile to raise or lower.

MAG-AMP DRIVE *continued*

from slack chain, and give good repetitive accuracy in positioning the missile, a spring-loaded take-up is used to keep 6000 lb tension on the chain. This consists of a sprocket mounted on antifriction bearings in a yoke at the end of a shaft, the shaft being contained in a tubular housing with the loading spring bearing against the end of the shaft. A conventional screw-nut takeup is used. A red band on the housing is uncovered by the spring cap to show when adjustment is necessary.

Arizona Div., Goodyear Aircraft Corp., Litchfield Park, Arizona, designed and builds this erecting system under contract with Convair-Astronautics, San Diego, Calif. Stanley M. Gorgas, engineering specialist headed the design group.

US RUBBER **PowerGrip** "TIMING" BELTS



Why are today's outboards streamlined, faster, dependable?

A good deal of the reason is U. S. PowerGrip "Timing"® Belts, invented and perfected by "U. S." Engineers, now in use on the majority of the new outboard motors. PowerGrip gives a positive, non-slip drive. It assures constant electrical output without chance of slip-up—generator performs perfectly always.

Other advantages that make PowerGrip indispensable:

- Trouble-free — no lubrication, noiseless, corrosion-resistant.
- Compact—short center-to-center distance, light weight.
- Safer—no slip to wear out belt, or cause breakdowns.

The U. S. PowerGrip "Timing" Belt drive may well improve your product, just as it has improved outboard motors. These drives are available in stock for every industry from U. S. PowerGrip "Timing" Belt Distributors, from fractional to 1000 hp.

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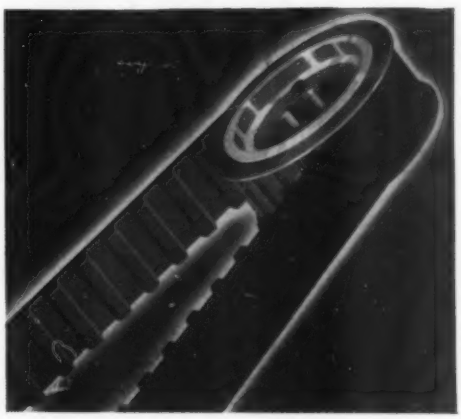

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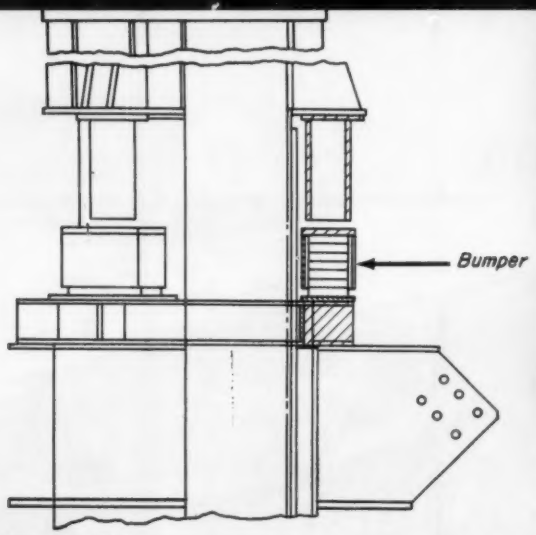
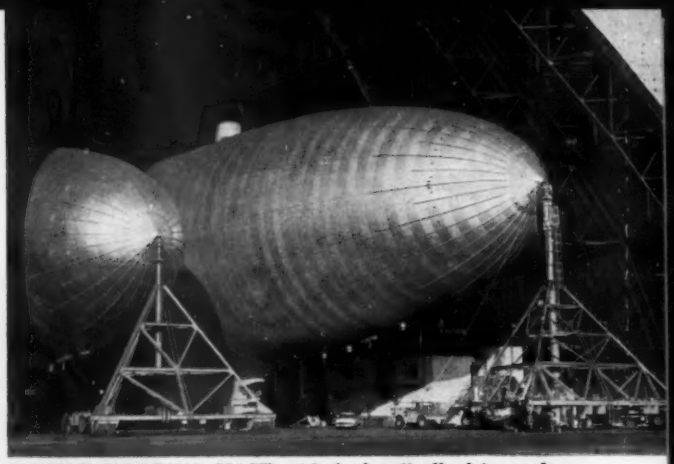
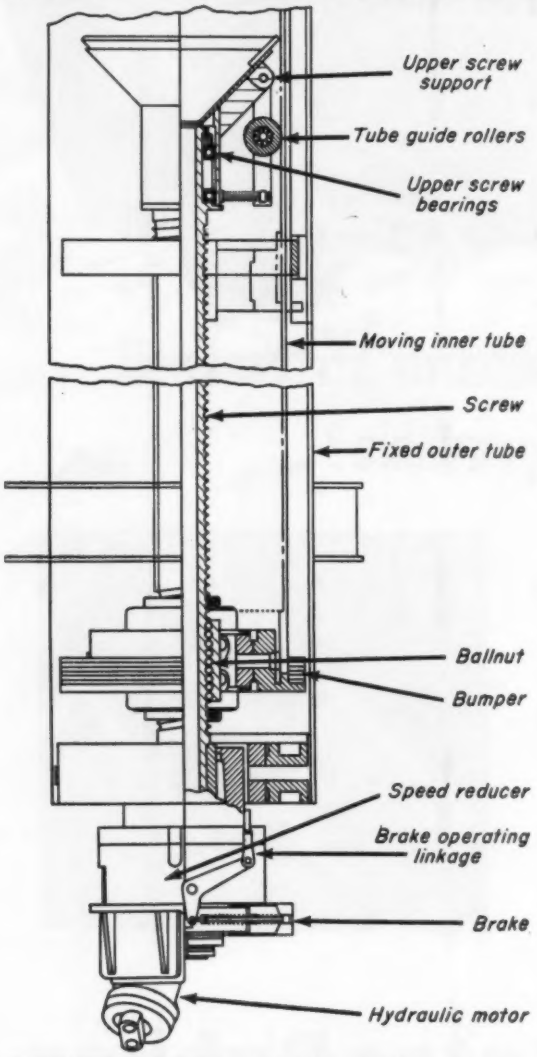




MOBILE MOORING MAST with hydraulically-driven elevating mechanism is at right.

Ball screw smooths blimp mooring



ELEVATING DRIVE is a 15-ft long, 4½-in. dia ball screw driven by a hydraulic motor through speed reducer.

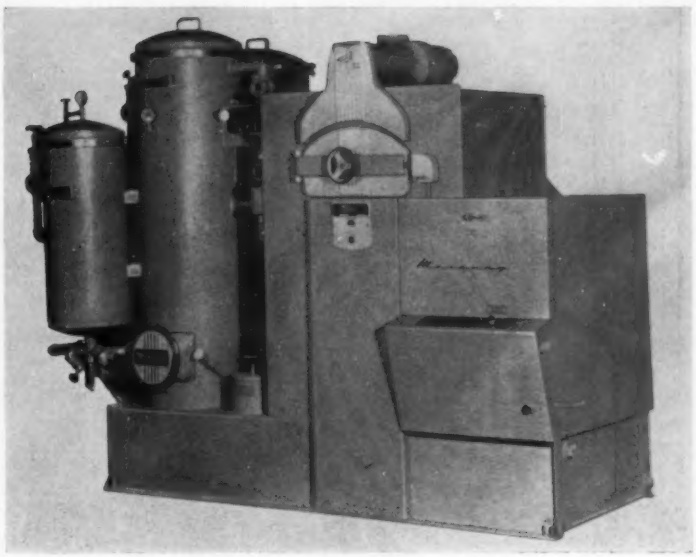
A 15-FT. LONG, 4½-in. diameter ball screw, driven by a hydraulic motor, extends and retracts precisely to speed blimp mooring. The ball screw controls elevation of the nose fitting of a new mobile mooring mast that handles large non-rigid airships like the Goodyear ZPG-3W.

The mast and elevating mechanism are mounted at the center of a platform. The movable and fixed portions are concentric tubes. The ball nut is mounted at the lower end of the inner tube. Lower end of the screw is driven by the hydraulic motor through a speed reducer mounted at the lower end of the outer tube. A spring-applied, hydraulically-released brake is also mounted at the lower end of the outer tube. The brake automatically releases when hydraulic pressure is supplied to the motor to operate it. Conversely, when the motor is stopped or hydraulic pressure interrupted for any reason, the brake is applied.

Prime mover for the winch power package is a 6-cylinder gasoline engine, governed to operate at 1800 rpm. In addition to driving the hydraulic pump to supply fluid to the elevating motor, the engine must drive a winch for maneuvering the airship into mooring position, a coolant pump for an eddy-current coupling, and an ac generator to supply power for lights and control circuits. So, hydraulic drive not only provides fast response and precise control, it greatly simplifies the power transmission system.

Despite the label *lighter-than-air* often used with airships, present operating practice is not to use enough helium in the bag so that craft will be weightless. This means that forward motion and aerodynamic lift are necessary to actually get the airship in the air. In the case of the ZPG-3W airship, 21,000 lb must be supported and elevated by the mooring mast and its elevating drive.

This mobile mooring mast is a development of the *Goodyear Aircraft Corp.*, Akron, Ohio. They also make the airships.



DUAL SPEED RANGE is needed for washing and extracting cycle of dry cleaning machine.

Air-operated clutch selects two speeds

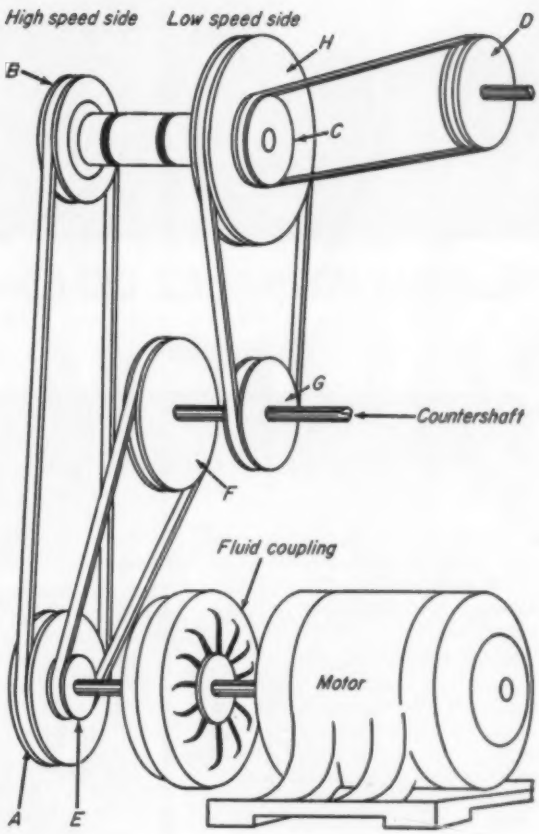
HIGH OR LOW speed is selected on a washer-extractor dry cleaning machine by an air-operated duplex clutch. The clutch selects either 2000 or 90 rpm running speed for the final drive.

Drive motor delivers 2 hp at 1750 rpm. A fluid coupling between the motor and the drive train lets the motor come up to speed instantaneously while the load is picked up gradually. This means that the motor output is based on running, rather than starting, requirements and can be much smaller. Output of the fluid coupling drives two sheaves, small (*E*) and large (*A*), adjacent to each other on the output shaft.

The large sheave is in the high speed system. It drives to the duplex clutch through a somewhat smaller sheave (*B*). Engaging the high-speed side of the clutch lets sheave *B* drive sheave *C*. In turn, *C* drives *D* through a V-belt. Net result is a slight stepup in speed to 2000 rpm delivered to the final reduction from *D*.

In the low-speed part of the drive, sheave *E* drives a countershaft through sheave *F* and a V-belt. The countershaft drives sheave *H* through dual V-belts. When low speed is selected, the duplex clutch disconnects the high-speed drive and connects sheave *H* to sheave *C*. Output of sheave *D* to the final reduction is then 90 rpm. Clutch unit is only 3-in. in diameter. Air for operation is supplied through rotary unions at each end of the clutch shaft. Final drive reduction is $2\frac{1}{2}$:1 to give cleaning drum speeds of 30 to 800 rpm.

This dual-speed drive is the development of engineers at *Mercury Cleaning Systems Inc.*, Evanston, Ill., for their new Model PER 50 Numatic cleaning unit.



Announcing Worthington QD Sheaves with the

GOLDEN SCREWS

To demonstrate to you that the exclusive two-screw design is practically worth its weight in gold, all Worthington QD (Quick Detachable) sheaves now have two golden screws.

The clamp screw simplifies installation and assures permanent alignment. You can install QD sheaves one part at a time. No heavy rim and hub combination to delicately inch into place. You just slide the hub on the shaft and permanently lock it in position with the clamp screw. Then you slide the sheave rim into position on the hub. This job is simplified because you engage the large end of the sheave with the small end of the hub. To change speed you simply install another sheave on the hub which remains anchored to the shaft by the clamp screw.

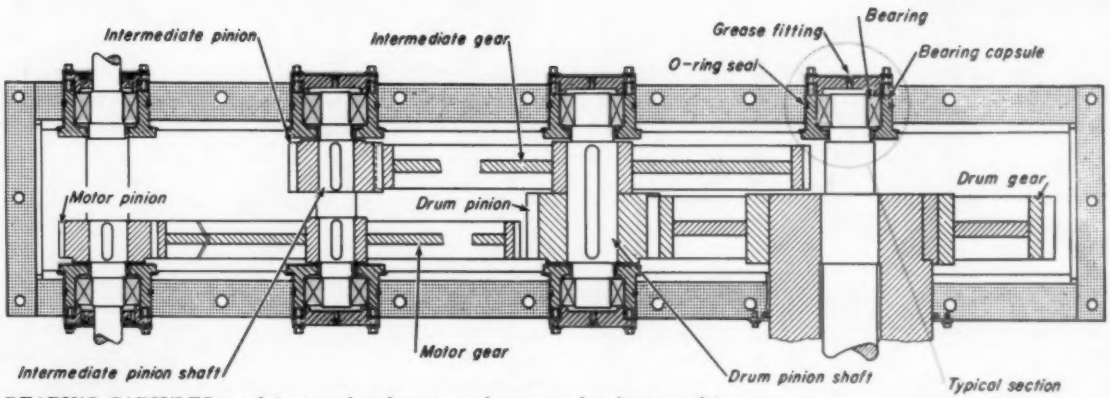
The set screw prevents "key drift." It locks the key securely in place, avoiding the danger of the key drifting off and becoming a safety hazard. This feature is appreciated by plant operators who first brought this potential danger to Worthington's attention.

You tighten the set screw without distorting the hub. The clamp screw allows you to locate the hub on the shaft. The locked hub then permits you to tighten set screw on key without distortion.

You can get Worthington QD sheaves anywhere in the U.S. More than 350 distributors carry Worthington sheaves and Worthington-Goodyear Green Seal V-belts. For your copy of a 100-page Multi-V-Drive Manual on how to select the right sheave and V-belt write to Worthington Corporation, Section 79-15, Oil City, Pennsylvania. In Canada: Worthington (Canada) Ltd., Brantford, Ontario.

WORTHINGTON

For more information Circle No. 30 on Reader Service Card



BEARING CAPSULES used in speed reducers on large overhead crane drives.

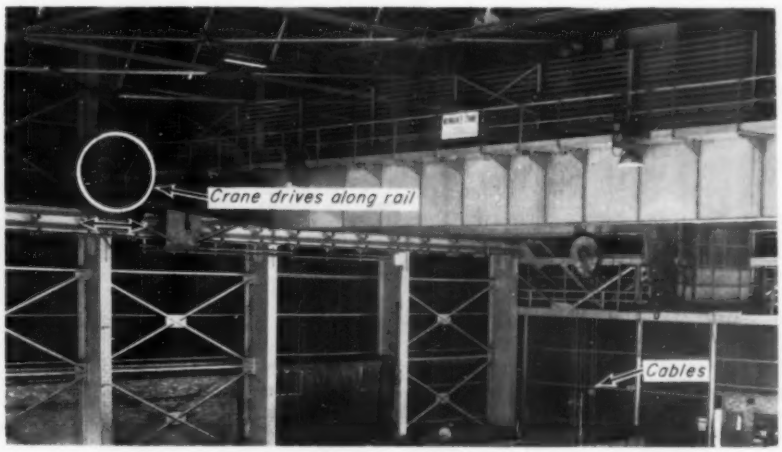
Capsule bearing protects reducer on crane

INDIVIDUAL CAPSULES or small housings for antifriction bearings support the gears and shafts in a speed reducer on a large crane drive. The capsules protect the bearings from damage from metallic particles and other contaminants in the gear oil. They also protect the gear case and all other components from damage resulting from bearing failure.

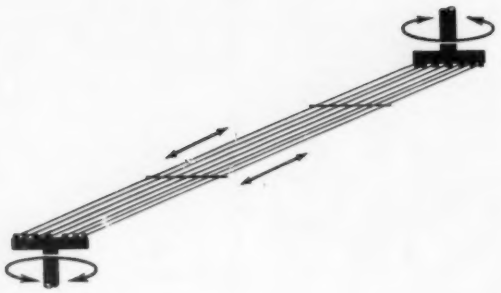
The capsule is a small cylindrical housing bored to fit the bearing OD and turned on the OD to fit a bore in the side of the housing. A gasketed cover, which is drilled and tapped for a grease fitting, closes one end of the capsule. The other end, through which the shaft passes, has a labyrinth seal around the shaft. A shoulder on the capsule positions it endwise in the housing bore. An O-ring seals the OD of the capsule.

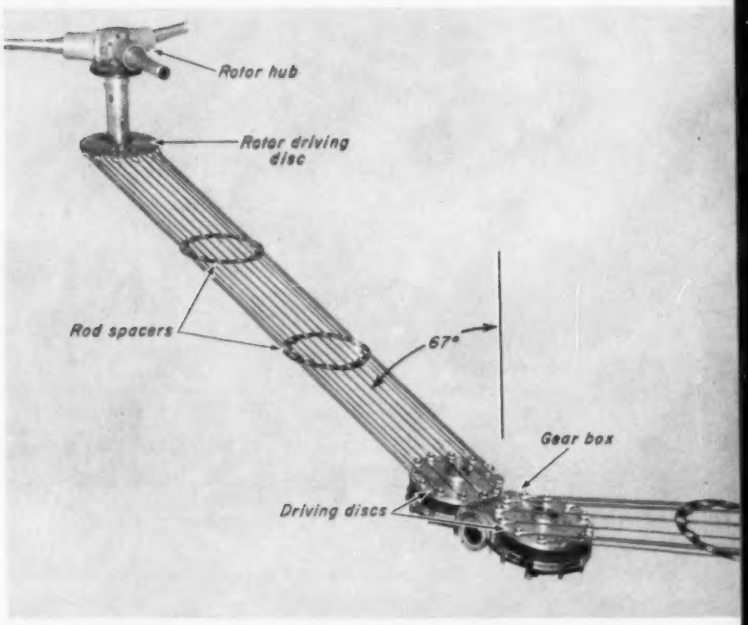
Other specific advantages are: protection of the bearings from mechanical damage and contamination when the reducer is disassembled; damage from bearing turning in its bore confined to the relatively inexpensive capsule; bearing replacement is much simpler; any bits and pieces of a failed bearing are contained in the capsule to prevent damage to other parts of the speed reducer from the metal fragments.

This method of bearing mounting is used by *Milwaukee Crane Div., Industrial Enterprises*, Milwaukee, Wis., with 3 to 6-in. bore bearings.



LARGE OVERHEAD CRANE uses capsule bearings in speed reducers at Jones & Laughlin Steel Corp, Aliquippa Works.





LIGHTWEIGHT ANGULAR DRIVE results from transmitting power by rods in tension. Transmitting force by tension alone always requires less material than transmission by compression or twisting.

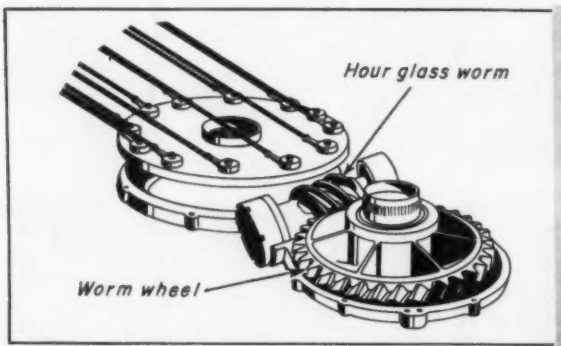
Rods in tension make lightweight drive

SMOOTH ROTARY POWER TRANSMISSION at an angle of 67 deg is gotten from 12 rods spaced at 30 deg around the periphery of two discs. Acting like spokes on a wheel, the drive eliminates all backlash torsional deflection normally found on a torque tube drive. These considerations prompted the design for powering counter-rotating, intermeshing helicopter blades.

Weight reduction also results from this design. The twelve rods and rod end bearings used to drive one rotor weigh only 7 lb. Discs rotate in parallel planes.

The rods are 145,000 psi tensile strength carbon steel. They are mechanically comparable to connecting rods. The points of attachment to the discs would be comparable to crank pins. Since the rods go over-center during operation, only six of them are actually carrying the load at any given moment like the top spokes in a bicycle wheel. Input to the tie rod drive is from a figure-eight-shaped gear box which contains an hourglass worm and two worm wheels. The two worm wheels drive discs, mounted atop the box, in opposite directions. Ball bearing rod ends are fastened to these discs. A fan-cooled, 7-cylinder radial engine is the power source.

This drive was developed originally by Fred Landgraf, *Landgraf Helicopter Co.*, Los Angeles, during World War II and has recent refinements. Mr. Landgraf is now employed as an engineer by Ryan Aeronautical Co. Development of Ryan's VTOL was one of his recent projects.



GEARBOX COMPONENTS. Hourglass worm drives two worm wheels which in turn drive discs bearing pins to which the rod end bearings are attached.

LANDGRAF HELICOPTER during test flight.

Timing belt damps vibration, eliminates noise

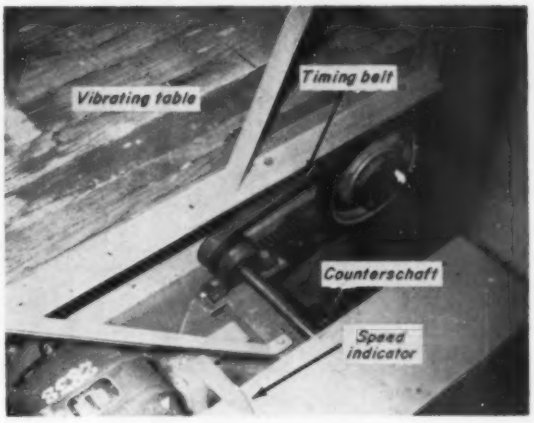
TIMING BELT DRIVE on a carton testing machine eliminates noise by stopping unwanted vibration. The belt lets the machine run at higher vibrating speeds replacing a chain and sprocket drive previously used.

Timing belt is the second of two reductions between the drive motor and the machine table. First reduction is through sheaves and wide-range V-belt. A variable-pitch sheave on the 1725-rpm motor on a sliding motor base allows speed adjustment.

The machine is operated over a speed range of 120 to 310 rpm final input to the table. Before modification maximum speed was limited to 240 rpm by noise and vibration. Speeds are indicated by a scale attached to the top of the V-belt guard and a pointer which travels with the motor on its sliding base.

Test runs check strength as well as sealing ability of cartons filled with granular material at *Cornell Paperboard Products Co.*, Milwaukee, Wis., where this improvement was made.

CARTON TESTER uses timing belt drive to eliminate noise and vibration.



TIMING BELT DRIVE from countershaft to vibrating table eliminates noise and vibration produced previously by chain.

TIMING BELT drive eliminates problems with other types of belt drives from airborne abrasives.

Timing belt works well in abrasive atmosphere

TIMING BELTS eliminate several drive problems in a slag crushing plant where airborne abrasive material is present. Both V- and flat-belt drives have been replaced.

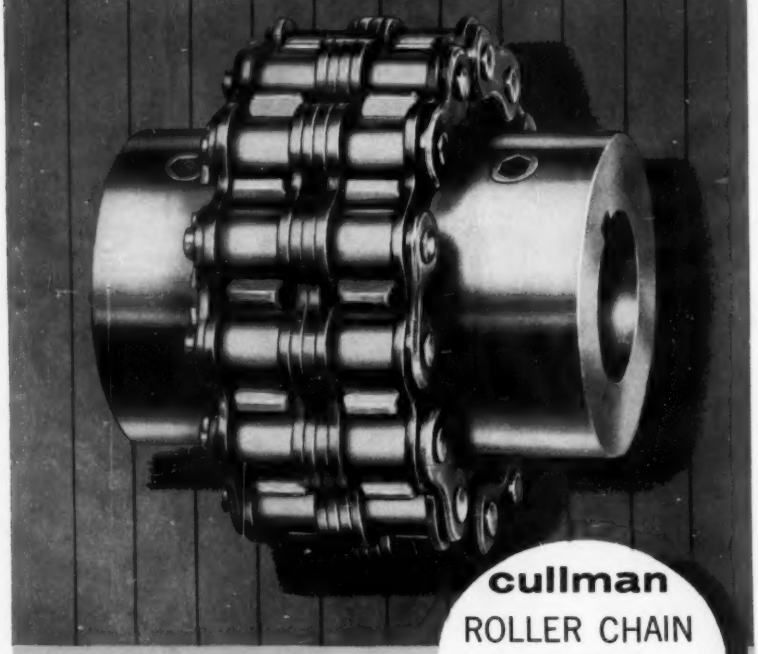
Troubles with the two other types of belt drives were different but timing belts solved the problems.

With flat belts, the airborne material built up on the pulleys or wore away the crown. The belts rode off the pulleys.

With V-belts, the abrasive material polished the sheaves. Excessive tension was required after short periods to keep belts from slipping. The tension resulted in early bearing failures on both driving and driven shafts.

The drive shown had previously been equipped with both V- and flat belts at a plant of the *Buffalo Slag Co.*, Buffalo, N. Y. Another advantage of the timing belt in this application is that 6:1 reduction was gotten in one step, rather than the two previously needed, because of the positive engagement of the timing belt.

For Good Connections *with* Angular Corrections!



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STRONG—ALL STEEL
POSITIVE—MINIMUM BACK LASH
EFFICIENT—98-99%

CULLMAN FLEXIBLE COUPLINGS are designed to correct angular misalignment between two shafts or in connecting a motor directly to a machine. They allow for dissimilar shaft diameters and some radial thrust. Furnished complete with keyways, setscrews and hardened teeth. Cullman couplings accommodate bore sizes from 3/16" to 4⅝" diameter. Off-the-shelf service on fractional to 500 horsepower power ratings.

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For more information circle No. 10 on Reader Service Card

CONTINUED *from page 30*

Ball bearing line

Utility line provides substitutes for precision bearings in applications where such bearings are not really needed. They are made from high carbon steel, allowing price reductions over other types.

Global Ball & Bearing Co., Inc., New Hyde Park, N. Y.

Circle number 217 on reader service card

Small diameter motor

New fractional hp MicroMotor, type AO, is 4-⅛ in. dia but has high performance abilities of larger motors.

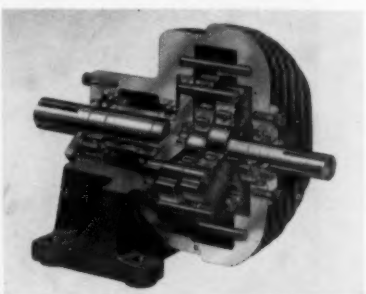
4- or 6-pole design, ⅛ through 1/50 hp. Available with internal fans, totally-enclosed or open-ventilated styles. Suitable for heating, air conditioning, appliance fields.

Redmond Co., Inc., Owosso, Mich.

Circle number 218 on reader service card

Cycloid drive

Hi-Range cycloid-type reduction drives are 40 to 60 percent smaller than other types of reducers with comparable ratings, offer a wider range of torque and give higher torque than other kinds. Sizes vary from small units for instruments to

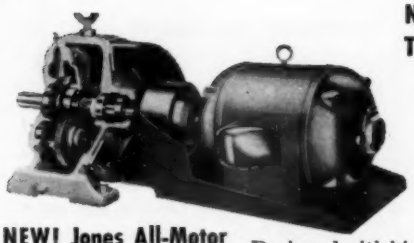


drives for large machine tools.

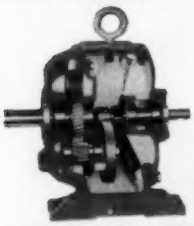
Black Tool, Inc., Denver, Colo.

Circle number 219 on reader service card

Continued on page 44



NEW! Jones All-Motor Type Gearmotors

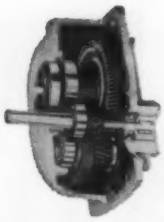


NEW! Jones Integral Type Gearmotors

Designed with high-hardness gearing for longer life. One-piece low-speed end housing construction insures gear alignment and prevents oil leakage. Compact design. All three types available for foot-mounted or flange-mounted installation, and for horizontal or vertical application. Capacity is up to 250 hp.

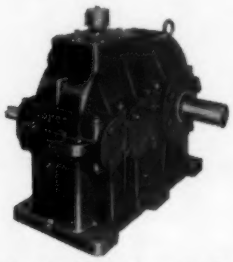
NEW! Jones In-Line Helical Reducers

NOW!



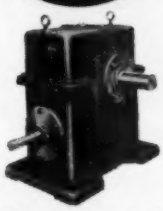
NEW!
Jones Shaft-Mounted Reducers

High-hardness gearing gives compact design and extra service life. Positive sealing against oil leakage through double lip type seals. All gearing straddle-mounted between anti-friction bearings. Single and double reduction units to 40 hp. Six standard sizes. Flange-mounted units available in three standard sizes.



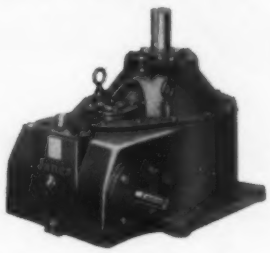
Jones Herringbone Gear Reducers

Accepted throughout industry; balanced design, heavy-duty roller bearings, rugged cast iron housing for reliable service and low maintenance costs. The most complete parallel shaft line in industry.



Jones Worm Gear Reducers

Horizontal and vertical shaft types available with ratios to 80:1. Heavy-duty roller bearings throughout with high-test cast iron housings for positive gear alignment.



Jones Worm-Helical Reducers

For vertical output shaft service; ratios from 25.63:1 to 357.5:1. Provide optimum combination of initial cost, efficiency, and low maintenance. Proven in hundreds of installations; redesigned to incorporate latest improvements in metallurgy and reducer design.

Now from Jones:

SPEED REDUCERS FOR EVERY PURPOSE

One of the most comprehensive speed reducer lines in industry! With new shaft-mounted reducers, in-line helical reducers, and gearmotors, Jones now offers a wide selection for all your power transmission needs. New technical bulletins give you exactly the information you need for proper selection of units in accordance with latest A.G.M.A. ratings. Be sure to ask your Jones representative for copies, or write Hewitt-Robins, Stamford, Connecticut, for this literature:

All-Motor and Integral Type Gearmotors
Bulletin 12-22-J17
In-Line Helical Reducers
Bulletin 12-22-J18
Shaft-Mounted Reducers
Bulletin 12-22-J19
Herringbone Gear Reducers
Bulletin 12-22-100
Worm Gear Reducers
Bulletin 12-22-J13
Worm-Helical Reducers
Bulletin 12-22-J14

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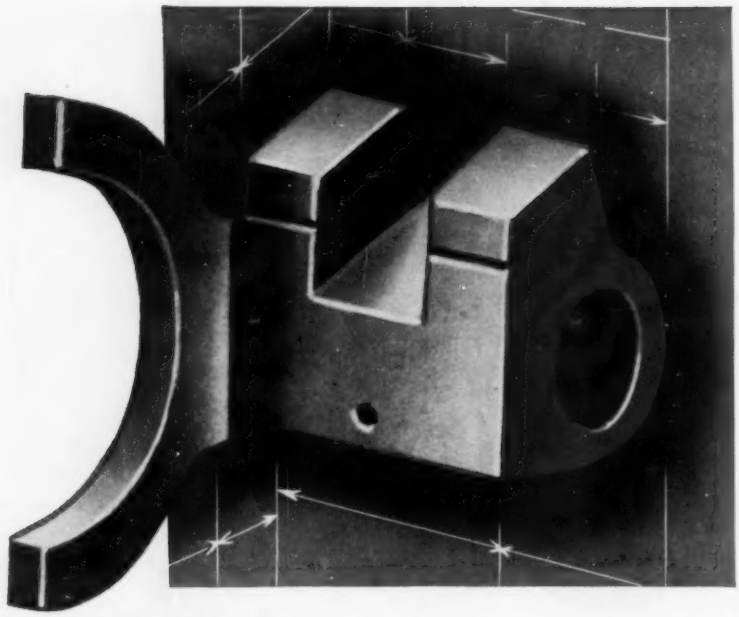
For more information circle No. 17 on Reader Service Card



this new part brings outstanding cost reductions...

The photograph is of a shifter fork used in the transmission of a very popular garden tractor in volume production.

Clearly evident is the economy that can be achieved by powder metallurgy over other previously used methods. The elimination of practically all machine work effects striking cost reduction.

Made of pure powdered iron, infiltrated with copper to give added strength and ductility, this part is intended to meet the higher physical properties of wrought metals.

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BUNTING SALES ENGINEERS in the field and a fully staffed Product Engineering Department are at your command without cost or obligation for research or aiding in specification of bearings or parts made of cast bronze or sintered metals for special or unusual applications.

...ask or write for your copy of...

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CONTINUED *from page 42*

Compact V-drives

High-strength belts and sheaves of new Ultra-V line can handle up to three times the horsepower of conventional V-belt drives in the same space. Belt cross-sections are reduced

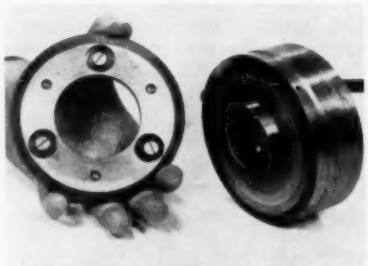
from five to three, and belts have greater side-wall area and arched tops for better alignment. Belt widths from 3/8 to 1 in. work for drives from 1 to 1500 hp.

T. B. Wood's Sons Co., Chambersburg, Pa.

Circle number 220 on reader service card

Face-tooth clutches

New series of stationary-field, electro-magnetic clutches come in five ratings, from 30 through 725 lb-ft of torque. Extreme compactness lends itself to use as machine tool feed, tracer and positioning drive devices. They may be buried in drivebox or



transmission and forgotten, since little or no adjustment or maintenance is required. For 24- or 90-v d-c operation.

ITE Circuit Breaker Co., Philadelphia, Pa.

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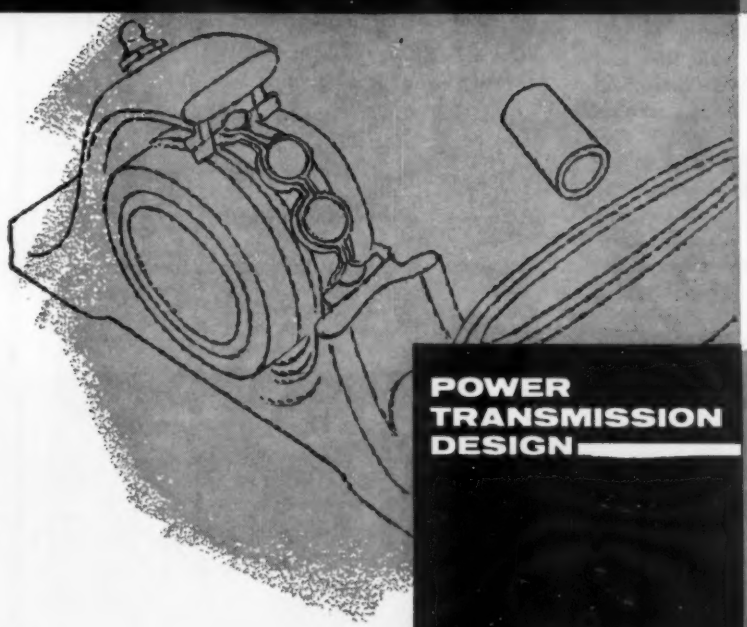
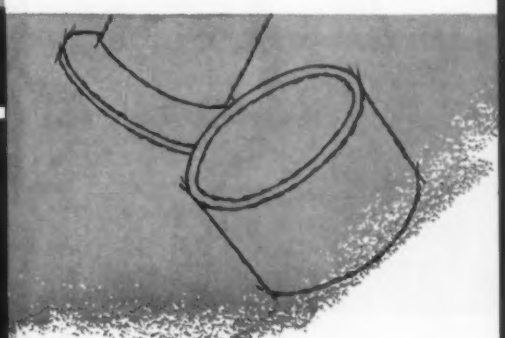
BEARINGS

DESIGN/APPLICATION



REGULAR MONTHLY SECTION OF IDEAS AND DEVELOPMENTS

POWER TRANSMISSION DESIGN



December 1959

How to compute oil flow through a sleeve bearing

By E. I. RADZIMOVSKY, *Professor, University of Illinois*

OIL FLOW through a bearing is necessary, not only to produce an oil film, but also to keep running operation cool. Cooling characteristics depend directly on rate of oil flow.

Circumferential Oil Groove

For a bearing with a circumferential groove, rate of flow depends on viscosity, diameter and length of bearing, radial clearance, eccentricity with which the journal operates, supply pressure, and arrangement of the hole or grooves.

In addition, pressure developed in the oil film, due to relative motion of the journal and the bearing, must be considered. Pressure exists only when the journal rotates under load. Therefore, pressure in the film, and consequently, rate of flow through the bearing, will be different in an operating bearing than in a stationary one.

However, high film pressure is developed in an operating bearing in the region where thickness of the lubricant film is relatively small.

Flow in the axial direction depends upon the cube of film thickness. Therefore, rate of flow through the loaded bearing depends mainly on the flow through the regions where thickness of the film is relatively large and pressure in the film is relatively low. Because of this, rate of flow calculated without considering influence of hydrodynamic pressure in the film will give only an approximation of actual flow under operating conditions.

Computations

Consider the flow of liquid through a bearing having a circumferential groove in the middle. Consider an element of area equal to dx times dy. The quantity of lubricant flowing in unit time may be derived by

$$dQ=\omega\, dx\, dy \qquad (1)$$

Velocity ω in the z-direction is

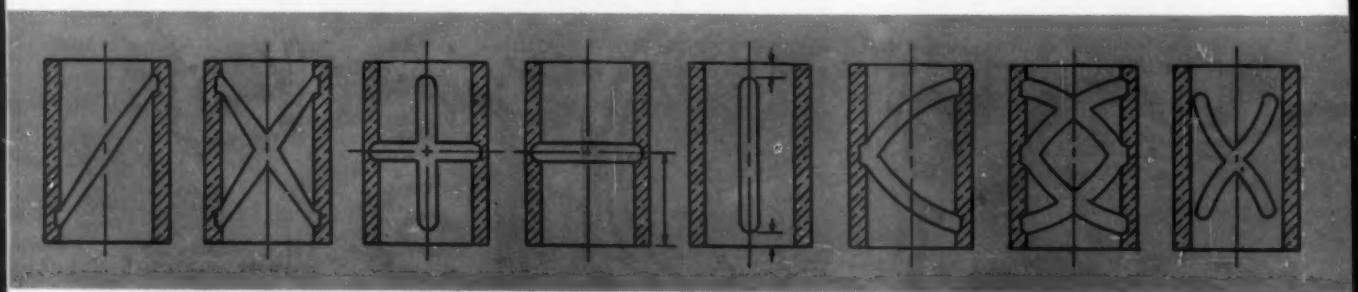
$$\omega=\frac{1}{2\mu}\cdot\frac{\partial p}{\partial z}(y-h)y \qquad (2)$$

Which takes the form

$$dQ=\frac{1}{2\mu}\cdot\frac{\partial p}{\partial z}(y-h)y\, dx\, dy \qquad (3)$$

For a journal bearing, thickness of the lubricant film

TYPICAL OIL GROOVES in sleeve bearings.



at any point is

$$h=c(1+n\cos\phi) \quad \text{.....(4)}$$

also

$x=r\phi$ and $dx=r\,d\phi$

Therefore

$$dQ=\frac{1}{2\mu}\cdot\frac{\partial p}{\partial z}y[y-c(1+n\cos\phi)]dy\,r\,d\phi \quad \text{.....(5)}$$

Upon integration

$$Q=\frac{\pi r c^3 p_i}{3\mu L}(1+1.5n^2) \quad \text{.....(6)}$$

This expression is for the rate of flow from one end of the bearing. The total rate of flow is

$$Q_g=\frac{2\pi r c^3 p_i}{3\mu L}(1+1.5n^2)\ \text{in.}^3/\text{sec} \quad \text{.....(7)}$$

The equation gives only an approximate value for rate of flow through a bearing having a circumferential groove in the middle because influence of hydrodynamic pressure in the film is not considered.

The rate of flow is proportional to the supply pressure p_i and to the cube of the clearance. The rate of flow is inversely proportional to length of the bearing and viscosity of the lubricant. The rate of flow is also influenced by the eccentricity of the journal.

In a heavily loaded bearing, attitude n approaches unity

$$Q_g=\frac{2\pi r c^3 p_i}{3\mu L}\times 2.5 \quad \text{.....(8)}$$

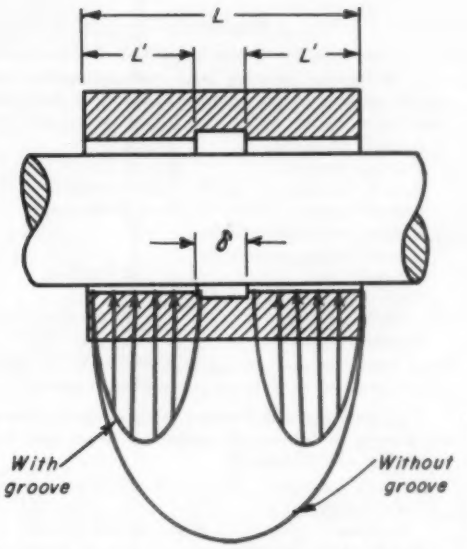
In a lightly loaded bearing, the attitude approaches zero and the rate of flow becomes

$$Q_g\cong\frac{2\pi r c^3 p_i}{3\mu L} \quad \text{.....(9)}$$

The flow of lubricant through a heavily loaded bearing with a central oil groove is about 2.5 times greater than that through a lightly loaded bearing.

Nomenclature

L	= *bearing length normal to direction of motion, in.*
L'	= *bearing half; groove separates from other half, in.*
N	= *journal speed, rpm*
Q	= *rate of flow, in.* ^{3}*/sec*
Q_g	= *rate of flow from both ends of bearing with circumferential oil groove, in.* ^{3}*/sec*
M	= *lubricant viscosity in film, centipoise*
c	= *radial clearance, in.*
d	= *journal diameter, in.*
h	= *film thickness; clearance between journal and bearing, in.*
$h_{min.}$	= *minimum oil film thickness, in.*
n	= *attitude of oil* $= e/c$
p_i	= *supply pressure at inlet hole, psi*
r	= *radius, in.*
t_o	= *effective oil film temperature, F*
ω	= *angular velocity, rad/sec*
μ	= *absolute viscosity of oil film, reyns, lb-sec/in*^{2}.
Φ	= *angular distance of inlet hole from reference*
Δ	= *width of circumferential groove, in.*



COLORED AREA shows influence of circumferential oil groove on oil film pressure.

Unfortunately, the flow in a heavily loaded bearing occurs mainly through the unloaded portion. The flow through the loaded region, where cooling is most needed, is relatively small because the lubricant film in this region is relatively thin. This does not mean that considerable rate of flow through the unloaded region does not help cooling. Heat generated due to viscous friction spreads in the entire bearing shell and is absorbed by the lubricant flowing mainly through the unloaded region. Besides, due to flow in the x-direction, cool lubricant continuously replaces heated lubricant between the journal and bearing in the loaded region.

Also, during each revolution, the journal surface passes the unloaded portion of the bearing and is cooled by the flow of cool lubricant.

Bearing with a Single Hole

Bearings with a single hole are the simplest and have advantages when compared with those having circumferential grooves. They have greater load-carrying capacity than bearings with circumferential grooves of the same characteristics under the same conditions.

However, the rate of flow is smaller with a single hole. Thus, a groove is preferred when the cooling effect of the flow becomes a critical factor. Many journal bearings are lubricated this way. The importance has been shown by placing this hole in the unloaded region, as close as possible to the point of minimum pressure in the oil film.

The rate of flow may be expressed by

$$Q_h=\frac{c^3 p_i}{3\mu}\left[\arctan\left(\frac{2\pi r}{L}\right)\right](1+1.5n^2) \quad \text{.....(10)}$$

Continued on next page

Problems

1. A journal bearing with circumferential oil-supply groove in the middle and forced feed lubrication operates under the following conditions:

Journal diameter	$d = 4$ *in.*
Bearing length	$L = 5.5$ *in.*
Radial clearance	$c = 0.0025$ *in.*
Journal speed	$N = 1900$ *rpm*
Minimum oil-film thickness under operating conditions	$h_{min} = 0.0005$ *in.*
Mean viscosity of lubricant in film	$Z = 15$ *centipoises*
Supply pressure	$p_i = 40$ *psi*

Find approximate rate of flow through the bearing, expressed in gallons per minute (gpm).

2. A full journal bearing with circumferential oil groove is lubricated under pressure and has following specifications:

Journal diameter	$d = 2.5$ *in.*
Total length of bearing	$L + \Delta = 5.0$ *in.*
Width of circumferential groove	$\Delta = 0.25$ *in.*
Radial clearance	$c = 0.00175$ *in.*
Effective (mean) oil-film temperature ..	$t_o = 235°F$
Maximum oil-film thickness under operating conditions	$h_{min} = 0.000175$ *in.*
Lubricating oil	*SAE 20*

Determine inlet (supply) pressure, p_i, required if, in order to control bearing temperature, rate of flow through bearing is Q = 0.065 gpm.

3. In order to control bearing temperature, rate of oil flow through a full journal bearing with circumferential oil groove is equal to $Q = 0.08$ in.^{3}/sec. Bearing has following specifications:

Journal diameter	$d = 2.0$ *in.*
Bearing length (total)	$\Delta + L = 3.25$ *in.*
Width of circumferential groove	$\Delta = 0.2$ *in.*
Mean oil-film temperature	$t_o = 235°F$
Attitude under operating conditions	$n = 0.85$
Inlet (supply) oil pressure	$p_i = 32$ *psi*
Lubricating oil	*SAE 20*

Determine what radial clearance bearing must have.

Send your answers to "The Editor".

COMPUTE OIL FLOW *continued from preceeding page*

The comparison of calculated results from equations 7 and 10 shows that Q_g is greater than Q_A in bearings having all the same characteristics, with exception of lubrication arrangement. This also shows that the difference in the rate of flow increases with an increase in ratio between length of the bearing and diameter.

Equations 7 and 10 give only a first approximation for the rate of flow. Experiment shows that the actual rate of flow is smaller than that determined by the two equations.

Oil Grooves

Grooves and holes deliver and distribute lubricant. However, grooving on a bearing surface reduces effective bearing area and in some cases interrupts continuity of the active oil film, thus decreasing load-carrying capacity. From this standpoint, an "ideal" bearing should have a plain cylindrical surface without any grooves. The lubricant in such a case must be supplied under pressure through a single hole located at the point of lowest pressure.

Actually, such a bearing is not always practical, and certain types of grooving must be used. If grooves must be used to provide proper lubrication, they must be so designed that their negative effect on performance is minimized.

The type of grooving selected depends upon the conditions under which the bearings operate. In general, grooving depends upon the following:

1. *Manner in which oil is delivered, such as by means of oil rings, splash lubrication, flooded lubrication, forcing oil into bearing under pressure.*
2. *Whether lubricant is delivered through bearing shell or through shaft.*
3. *Whether load acting on shaft is vertical or is acting in some other constant direction, or direction of the load is variable.*
4. *Whether lubricant is used only as means of lubrication or is used also for cooling.*
5. *Whether bearing must be considered as lightly, moderately, or heavily loaded.*
6. *Whether journal is part which rotates or both journal and bearing are in motion during operation.*

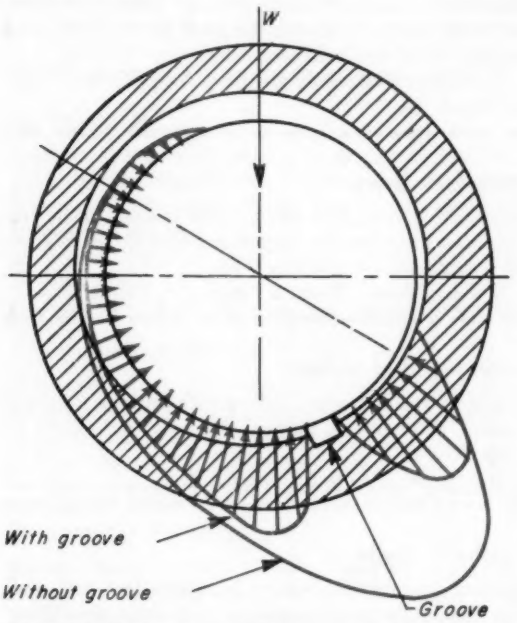
The type grooving that should be used depends also upon speed, unit pressure and material. Because of the great variety of factors influencing grooving, there are also many different grooving methods. The single hole arrangement is the simplest and most widely used. A bearing with a single hole has greater load-carrying capacity than one with a circumferential groove, but if the bearing is lubricated under pressure, rate of flow is smaller than that with a circumferential groove. This last property may be a disadvantage if cooling conditions are critical.

Bearings with this arrangement are usually stationary and the journals rotate. The external load should be applied in a constant direction, or the direction should vary only within narrow limits so that the oil hole is always in an unloaded region.

In a bearing with a hole and axial groove, the groove assists in initial distribution of lubricant. Such a bearing acts similarly to one with a single hole and is usually found where splash lubrication is used, or when a lubricant is delivered under low pressure. It is important that the groove be located in an unloaded region.

In a bearing in which lubricant is delivered through

the rotating shaft, it may or may not have an axial groove. If there is a groove, the external load on the shaft must be directed in such a way that the groove will be located in the unloaded region. Without the axial groove, the bearing load may be applied in any radial direction.



COLORED AREA shows influence of axial oil groove on oil film pressure.

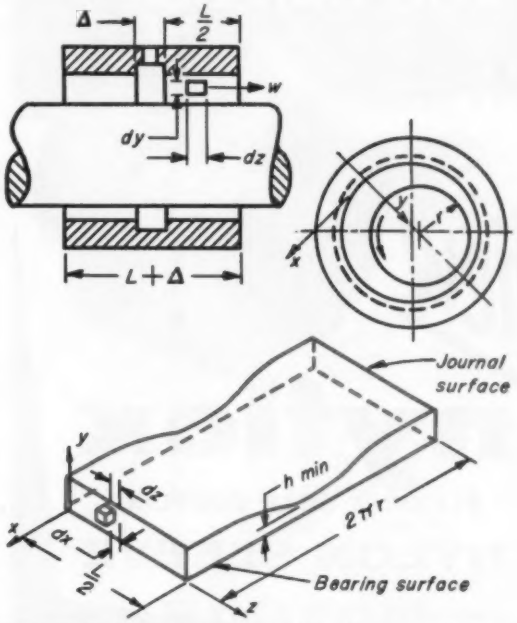
This drawing shows the influence of an axial groove on the pressure distribution in a hydrodynamically-lubricated bearing, if such a groove is located in the loaded region.

In this type bearing, the groove is made in the shaft instead of in the bearing shell. This is done when the shaft and the applied load rotate together, so that the axial groove moving with the journal always remains in the unloaded region. The same arrangement may be used if the journal is stationary and the bearing rotates around it. In this case, load on the bearing must be applied in a constant direction, or its direction must vary within such limits that the groove on the journal remains in the unloaded region.

For a stationary bearing and rotating shaft that has an oil ring, the load must act downward in a vertical, or close to a vertical, direction. The bearing has a slot in the upper half of the shell for a ring or chain. Sometimes the upper part also has axial or spiral grooves to assist oil distribution delivered by the ring.

A circumferential oil groove in a bearing decreases load-carrying capacity. The influence on pressure distribution is shown in the drawing. A circumferential groove cuts a bearing, having length L, into two parts, each part having the length L'. If a decrease in the active length by an amount δ is neglected, so that $2L'$ is assumed to be equal to L, the load-carrying capacity of two short bearings in parallel is considerably smaller than the capacity of one bearing with a groove and having a length $L=2L'$. This is because each of the two short bearings has an L'/d ratio smaller, and consequently smaller load-leakage factor, than a bearing without circumferential groove having length $L=2L'$.

Thus the grooved bearing will have a greater attitude n than a comparable bearing without such a groove operating under identical conditions. Therefore, if load is limited by the assumed minimum oil-film thickness, this load is smaller than a permissible load for



COLORED AREA shows journal bearing opened flat as development drawing. Circumferential groove and oil film are shown.

a bearing without circumferential groove.

In general, a circumferential oil groove is justified if load varies in direction, so that an oil hole or axial groove in the unloaded region is not possible.

A circumferential groove must be placed exactly in the middle of the bearing. If this is not done, load capacity of one side will not be equal to the other side, and the journal will have a tendency to run with an eccentricity in each side of the bearing.

The active oil film is actually cut into two parts; pressure at the groove is equal to supply pressure. The maximum and the average pressure in each part is much lower than pressure in an uninterrupted film. Therefore, load-carrying capacity with an axial groove in the loaded region becomes significantly lower than that of a bearing without a groove. Delivery of lubricant to the bearing through such a groove will be difficult or even impossible.

For proper flow, edges of holes and grooves must be rounded. ▲▲▲

Adapted from Lubrication of Bearings by E. I. Radzimovsky; published June, 1959, by The Ronald Press Company, New York

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LITERATURE on drives and components

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Mechanics Universal Joint Div., Borg-Warner Corp., Rockford, Ill.

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Warner Electric Brake & Clutch Co., Beloit, Wisc.

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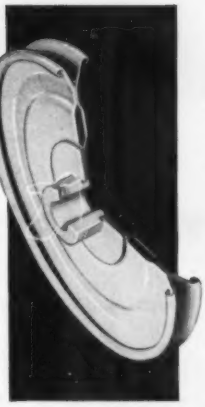

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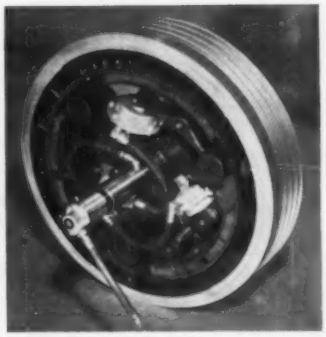

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By DANIEL BRANDT, *professor, Milwaukee School of Engineering*

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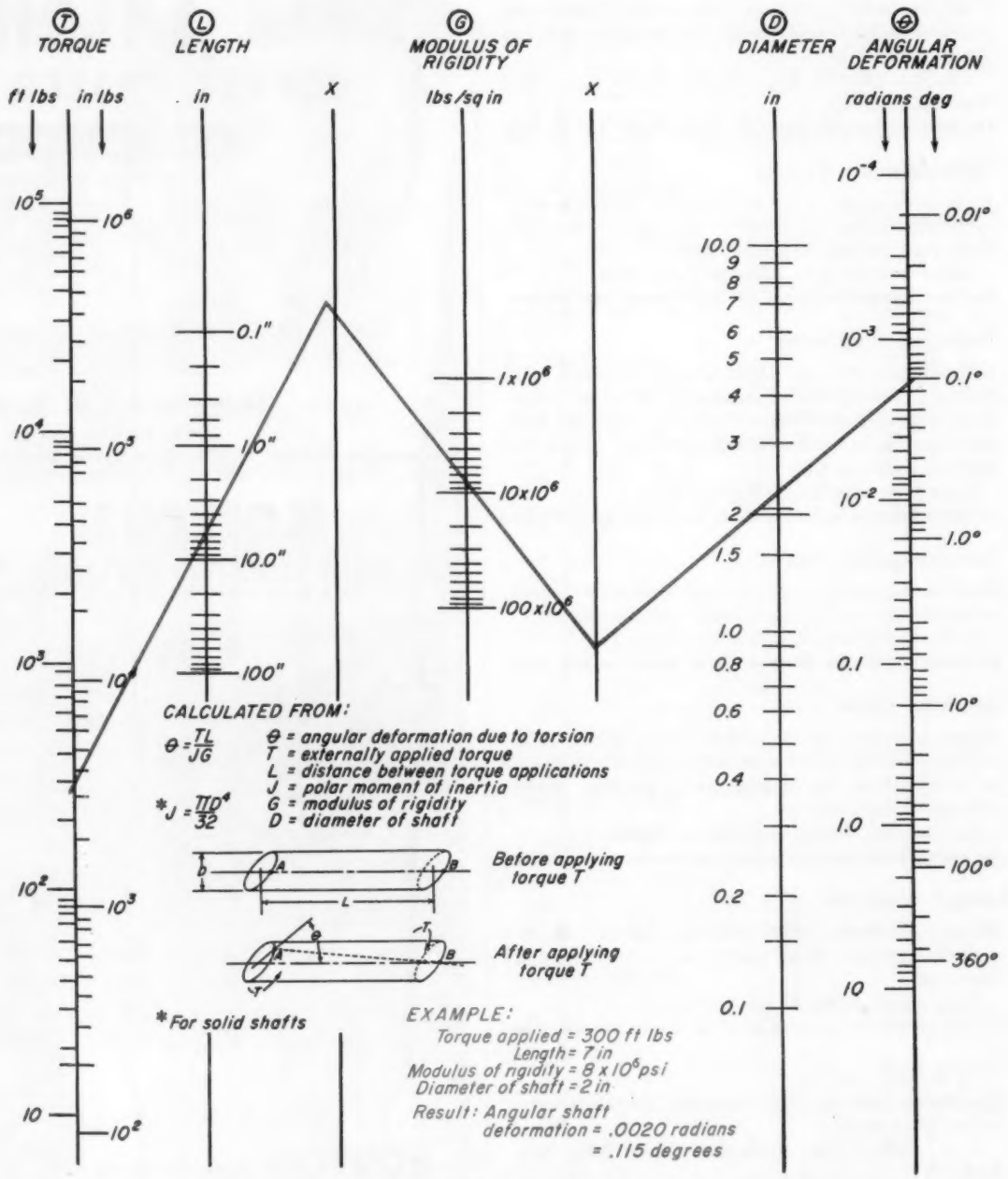

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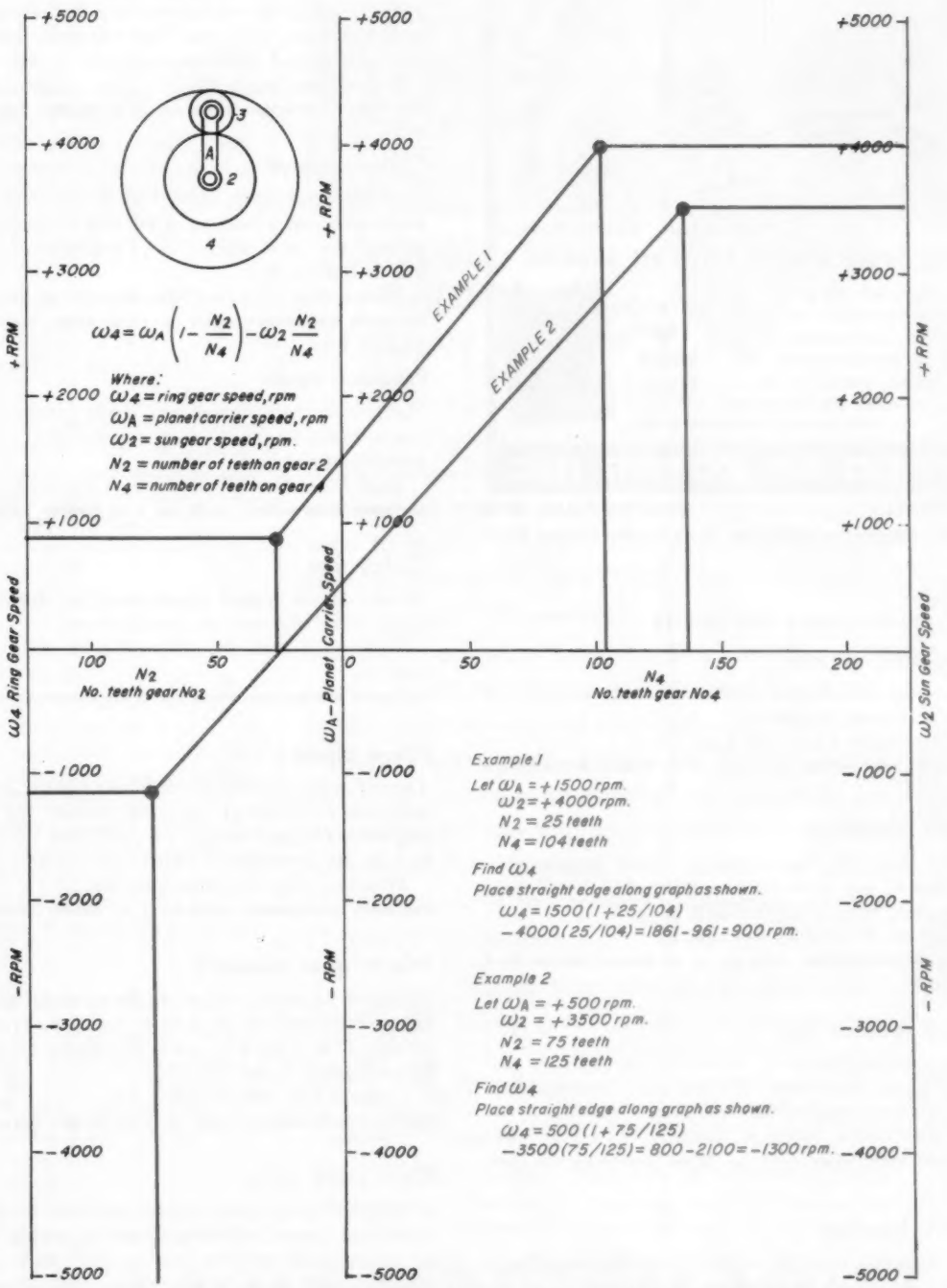
Simplified nomogram for planetary gears

By J. L. LACEY, *Niagara Falls, N. Y.*



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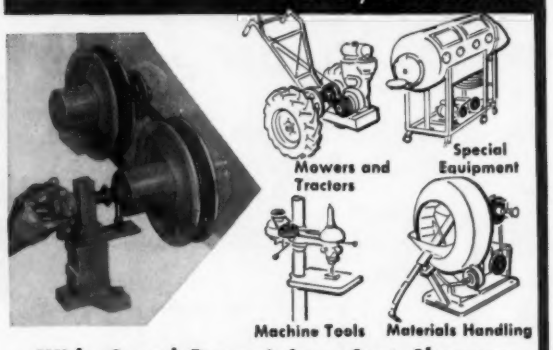

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LITERATURE *continued from page 51*

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Bulletin shows typical installations and furnishes capacity table, dimensions, specifications.

Rockford Clutch Div., Borg-Warner Corp., Rockford, Ill.

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Pillow blocks

Tapered roller bearing pillow blocks have unbreakable malleable housings, giving extra strength and permitting more compact design. 24 shaft sizes from 1-3/16 to 4 in. are described in bulletin BU-102A.

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Airborne Accessories Corp., Hillside, N. J.

For more information, circle no. 2 on Reader Service Card

Chain products

Prices and specifications on company's roller, conveyor, leaf, and block chain, chain accessories and attachments, flexible couplings and sprockets. Stock catalog RCS 2-58, 68 pages illustrated.

Whitney Chain Co., Hartford, Conn.

Circle number 50 on reader service card

Variable-speed drives

Bulletin 195, eight pages, gives full information on Speed-Trol drives. Typical installations pictured, with variety of reductions, mountings, and modifications indicated. Details on remote control are included.

Sterling Electric Motors, Los Angeles, Calif.

Circle number 51 on reader service card

Gear facilities described

Well-illustrated brochure shows company's gearing operations and facilities, discusses all phases of production from tooling to final inspection. Handy table of gear types, size ranges and advantages is included.

Advance Gear & Machine Corp., Los Angeles, Calif.

Circle number 52 on reader service card

Clutch couplings

Twiflex line of automatic centrifugal clutch couplings, flexible in all directions, with high shock absorption, no-slip characteristics. 8-page Bulletin CE-3 describes design features fully, with helpful diagrams. Dimension and ratings given in convenient tabular form.

Hilliard Corp., Elmira, N. Y.

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Magnetic disc brakes

Direct-acting, self-adjusting, hazardous location brake series are individually shown in bulletin BK-4005, 8 pages. Ratings and dimensions are included, along with formulas based on torque and thermal capacity to help determine selection of most efficient brake for a specific purpose.

Dings Brakes, Inc., Milwaukee, Wisc.

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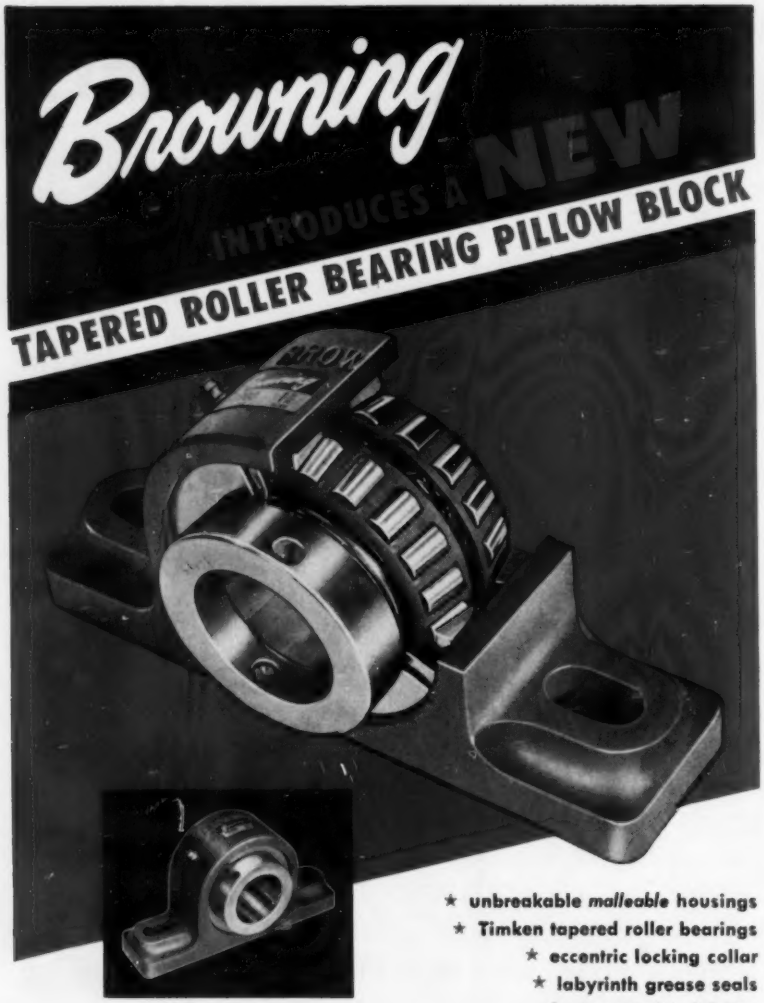

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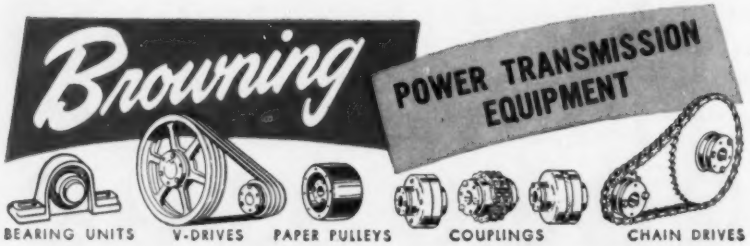
Browning distributors, coast-to-coast, stock these new tapered roller bearing units in 24 shaft sizes from 1 3/16" to 4"; completely assembled, ready for use. Ask your distributor for full information and new descriptive bulletin BU-102A. Or write **Browning Manufacturing Company, Maysville, Kentucky.**



For more information circle No. 7 on the Reader Service Card

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Adjustable-speed drive

Speed Variator is described in 8-page bulletin K-250. Typical applications are shown, complete specifications given. Variator is mechanical traction type with stepless speed control, choice of constant torque or constant hp series.

Cleveland Worm & Gear Co., Cleveland, Ohio.

Circle number 55 on reader service card

Electric tachometer

Small, heavy-duty speed indicating unit is for continuous service. Magneto will operate dependably in any position through a wide temperature range. Bulletin 580 describes components and gives selection data.

Electric Tachometer Corp., Philadelphia, Pa.

Circle number 56 on reader service card

Speed reducers

Twenty-page illustrated Book 2751 consolidates all of company's line of In-Line helical gear reducers in a single catalog. 20 reducer sizes in double, triple and quadruple reductions, with load ratings and service factors for each.

Link-Belt Co., Chicago, Ill.

Circle number 57 on reader service card

Vibration isolators

Several series of Barrymounts isolate vibration and noise caused or transmitted by motors or motor-driven equipment. Isolation efficiency up to 60 to 85 percent at 20 cps, within load limits of 30 to 260 lb per isolator. Bulletin 59-04.

Barry Controls, Inc., Watertown, Mass.

Circle number 58 on reader service card

Needle bearing report

Six-page technical paper by a company engineer discusses development, construction and application of loose needle rollers to planetary gear transmission systems. Load and speed determination, selection of parts is covered. Drawings, graphs and formulas aid in analysis.

Torrington Co., Torrington, Conn.

Circle number 59 on reader service card

Lubrication systems

Multi-Luber systems for automatic power lubrication of trucks, trailers, material handling equipment, farm implements and industrial machinery. Catalog 50 shows air-, vacuum- and manually-operated systems, applications, methods of operation and components.

Lincoln Engineering Co., St. Louis, Mo.

Circle number 60 on reader service card

Rate gyros

Bulletin RG-101 gives detailed information on three rate gyros claimed to cover almost all applications: lightweight, ac or dc motor in gyro for stabilization and instrumentation systems; dry-gas filled gyro for difficult environments; dual-rate style with one motor driving two separate wheels.

Humphrey, Inc., San Diego, Calif.

Circle number 61 on reader service card

Precision balls

Bulletin BU-1 presents company line of oem precision balls. It discusses raw materials, methods of manufacture, precision, finish, size and quantity. Eight-page booklet relates physical and chemical properties to recommended uses.

Industrial Tectonics, Ann Arbor, Mich.

Circle number 62 on reader service card

Speed reducers

Hi-Line series speed reducers are covered in new 65-page catalog. Pocket-size booklet gives fast location of pertinent engineering data, dimensions and application selection charts.

Ohio Gear Co., Cleveland, Ohio.

Circle number 63 on reader service card

Mail order catalog

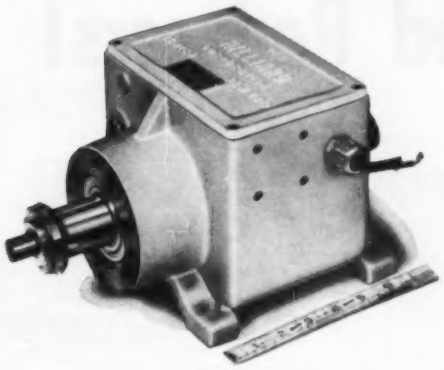
Thousands of surplus and bargain items are listed in 384-page book from famous "Gadgeteer's Heaven." Included are name-brand electric and hydraulic motors, power tools, speed reducers, couplings, pulleys and many other components and complete packages.

Palley Supply Co., Los Angeles, Calif.

Circle number 64 on reader service card

Continued on page 62

HILLIARD'S *New* "I.D.U."



A complete, packaged unit that gives you precise control of intermittent motion from a constant rotary power source!

Built-in features:

- Contains all the parts in one package.
- Can be installed as easily as a motor and needs only electrical connection.
- Self-lubricating for long life of 40,000,000 or more cycles.
- Operating speed from 40 to 400 R.P.M.
- Torque capacity 36 ft. lbs.
- No cumulative error in cycling.
- Instant engagement.
- Mount with direct coupling connection or use with belt, chain or gear drive.

Can be installed on existing equipment, designed into new machinery and re-used after production line changes.

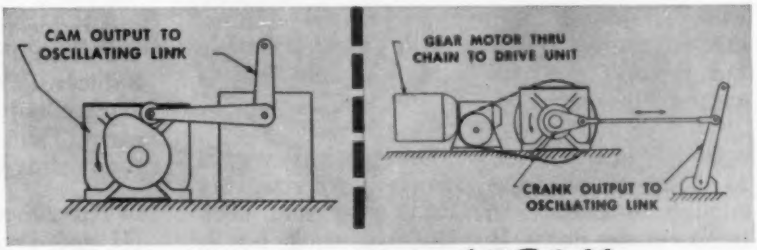
A single package unit that gives you precise control of intermittent motions . . . oscillate or repeat . . . clip and bend . . . shear or slash . . . raise or lower . . . index and position . . . from a constantly rotating source of power.

HILLIARD "I.D.U." eliminates the need of buying separate parts and assembling a "custom" machine with assorted mechanisms to control it.

"I.D.U." features highly flexible control—manual, mechanical or electrical—permitting "demand" type operations in fixed or variable cycles. A protected drive, totally enclosed in an oil bath housing, it is ideal for dusty, "steamed" or "washdown" conditions.

Write on your letterhead stating your intermittent motion problems and we will provide complete information.

Typical intermittent controls by "I.D.U"



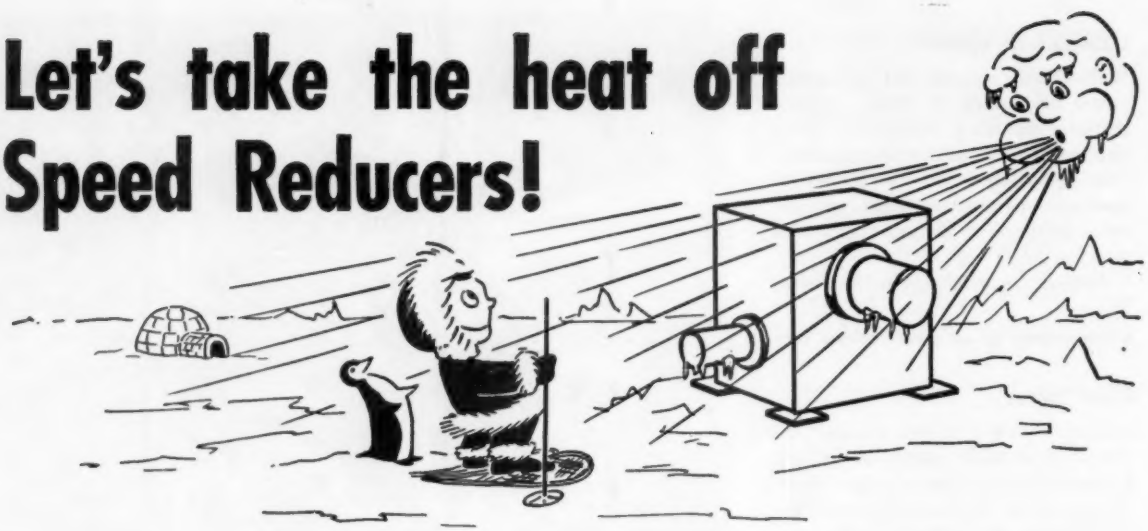
Basic Unit Price $289.00

Optional accessories extra

The HILLIARD Corporation

214 W. FOURTH ST. ELMIRA, NEW YORK

Let's take the heat off Speed Reducers!



A worm gear speed reducer is one of the toughest little customers in captivity. It reduces speeds day-in, day-out, with little complaint. While it works long and hard, it has limitations—set by ratio, center distance, RPM, mechanical and thermal HP ratings, etc. And, depending upon how precisely it was selected and fitted to the job requirements, it will do what it has to do.

But sometimes it's forced to play outside of its league. It must cope with job requirements that vary from here to there—normal 8 to 10 hour service without recurrent shock, the same length of service where there is some shock loading, continuous low-speed service and almost countless others. But the thing that really puts the pressure on reducers, the thing that's lurking in *every* set of job requirements—is h-e-a-t.

When you exceed the thermal capacity of a reducer for more than an hour or so, excessive temperature thins the lubricant resulting in wear; material, bearing and oil seal failures; etc. Of course, the proper lubricant will help but it can't cure the continuing problem of excessive heat.

So how can we lick this toughy? One way is to build the reducer housing oversize, big enough to radiate the heat away and keep temperatures down. But this type sticks out in aisles, louses up compact designs and barks shins. Then, we might try a smaller housing complete with fins on it to dissipate the heat. If this still doesn't work, another trick is to use a reducer with capacities and ratings a step above the ones we need. This is sending a man to do a boy's job. It's impractical, inefficient and costly. There *has* to be an easier, better, saner and cheaper way to do it. And there is!

In certain cases, where the size and type of reducer permits and where we can gain enough in thermal HP rating to keep heat generation in bounds, Cone-Drive Gears does it with fan-cooling.

What's that? Simple. Just add a fan to the worm shaft plus the necessary air shields, fan cover, etc., and presto!—heat is no longer a problem. The air shields direct the fan-pushed air over the fins on the lower portion of the reducer. The fins are shaped and spotted to guide the air stream where it is needed. Thermal HP ratings are boosted tremendously, as high as 147% above those of standard reducers in some cases! Those over-worked, over-heated reducers will now do the job you bought them to do.

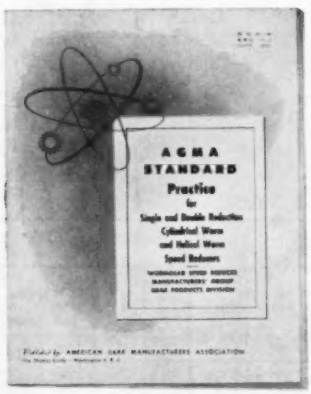
Other advantages? They're here in abundance. The size of the reducer stays the same. All parts on a Cone-Drive fan-cooled reducer are 100% interchangeable with parts for standard reducers. Oil capacity is identical. Shields are quickly removed without disconnecting the reducer. (This is important where severe operating conditions make periodic cleaning necessary). The reducer can also be operated *without* fan-cooling just by taking off the fan and shields.

This simple addition to standard Cone-Drive HU speed reducers might be just your answer—might save you some money. Write for Cone-Drive's Bulletin CD-218. It will tell you all about the full line of Cone-Drive double-enveloping worm gear reducers as well as the fan-cooled kind. Cone-Drive Gears, Div. Michigan Tool Co., 7171 E. McNichols Rd., Detroit 12, Mich.

For more information circle No. 8 on Reader Service Card

DE LAVAL offers new A.G.M.A. Gear Standards Booklet for Engineers

You will not want to be without this newly published American Gear Manufacturers Association booklet. It outlines the new standards for single and double reduction cylindrical worm and helical worm speed reducers.



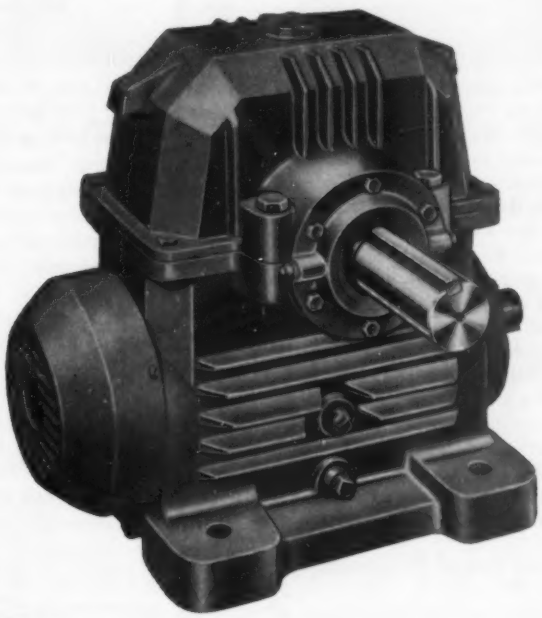
Get this new A.G.M.A. 440.03 booklet free of charge by request on your company letterhead.

This new standards booklet contains important design data including: Power rating of worm gears • Ratio correction factor (Km) • Materials factors (Ks) • Velocity factor (Kv) • Coefficient of friction(μ) • Thermal factor • Service factors • Efficiency • Overhung load capacity • Lubrication.

The materials factor (Ks) and the coefficient of friction (μ) are new, reflecting the latest advances made in worm gearing in the past few years.

We have also recently published our new Delroyd Worm Gear Sets Catalog 3800 and Delroyd Single Reduction Worm Gear Catalog 3805, which contain comprehensive information on the selection of these units.

De Laval furnishes worm gearing under the trade name DELROYD and has a complete line from 1⅛″ to 36″ center distance, in horsepower ranges from .04 to 700 and in ratios from 5: to 4900:.

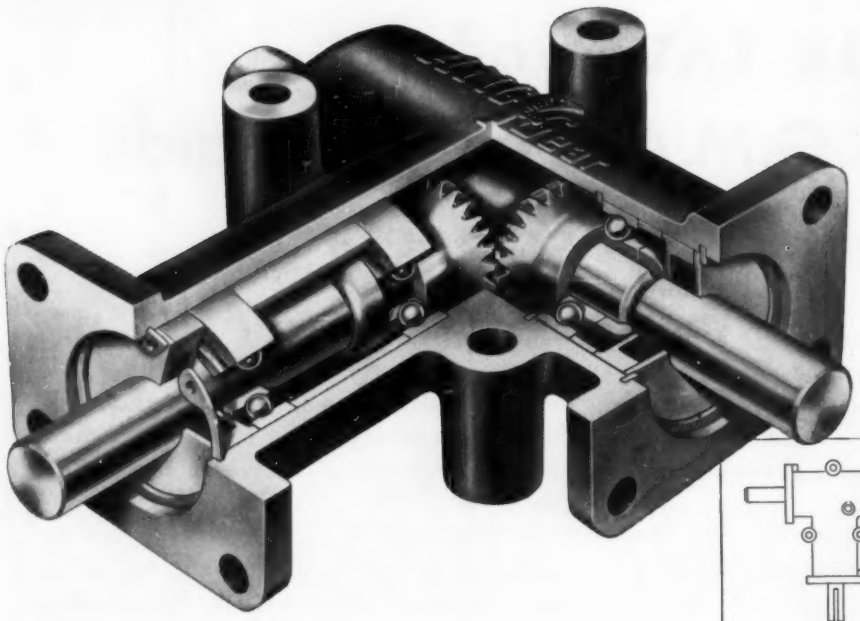


DE LAVAL *Steam Turbine Company*

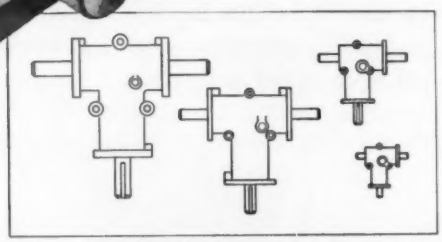
915 NOTTINGHAM WAY, TRENTON 2, NEW JERSEY

For more information circle No. 32 on the Reader Service Card

There is only one ANGLgear®... and it is made only by Airborne



Quality of ANGLgear construction is evident in cutaway view. ANGLgear gives you all the features of other drives, plus greater hp range (⅛ to 5); permanent lubrication; and Coniflex* design gears for more even load distribution, reduced wear, quieter operation.



ANGLgear is available from local distributor stocks in 4 sizes, 16 models, with various gearing and shaft options.

ANGLgear—introduced in 1951—is the *original* standardized right-angle drive. It is also the No. 1 product in its field—in sales, availability, quality, performance. Witness the thousands of satisfied customers who have bought ANGLgear to date—for applications ranging from simple manual control of valves to classified installations aboard nuclear submarines.

In design and construction, ANGLgear has been refined to the point of being virtually foolproof, provided it is not grossly overloaded. Take a unit off the shelf, install it, run it—for years. Attention is seldom required.

Besides being maintenance-free, ANGLgear is also easy to design into your power transmission systems because of its universal mounting feature. And it invariably costs less than other types of drives. ANGLgear is distributed nationally and is available immediately from local distributor stocks in the models listed here. Special sizes, special gear ratios, etc., can also be furnished. For complete engineering data, see our insert in Sweet's Product Design File, contact our local distributor, or write direct for new Catalog IA-58. *ANGLgear design template kits are available on request.*

*Trademark of The Gleason Works

BASIC MODEL DATA

Model	Type	Gear Ratio	HP	RPM Output Shaft	Ultimate Static Torque lb. in. Output Shaft	Shaft Dia.	Wt., lb.
R-300	2-way	1:1	1/3	1800	250	3/8	.5
R-300-2	2-way	2:1	1/5	1800	250	3/8	.5
R-310	3-way	1:1	1/3	1800	250	3/8	.5
R-310-2	3-way	2:1	1/5	1800	250	3/8	.5
R-320	2-way	1:1	1	1800	1000	5/8	2.2
R-320-2	2-way	2:1	3/5	1800	1000	5/8	2.2
R-330	3-way	1:1	1	1800	1000	5/8	2.4
R-330-2	3-way	2:1	3/5	1800	1000	5/8	2.4
R-333	2-way	1:1	2-1/4	1200	1500	3/4	8.7
R-333-2	2-way	2:1	2-1/4	1200	1500	3/4	8.7
R-335	3-way	1:1	2-1/4	1200	1500	3/4	9.0
R-335-2	3-way	2:1	2-1/4	1200	1500	3/4	9.0
R-340	2-way	1:1	5	1200	2500	1	14.5
R-340-2	2-way	2:1	5	1200	2500	1	14.5
R-350	3-way	1:1	5	1200	2500	1	15
R-350-2	3-way	2:1	5	1200	2500	1	15

AIRBORNE®

Engineered Equipment for Aircraft and Industry

AIRBORNE ACCESSORIES CORPORATION

HILLSIDE 5, NEW JERSEY

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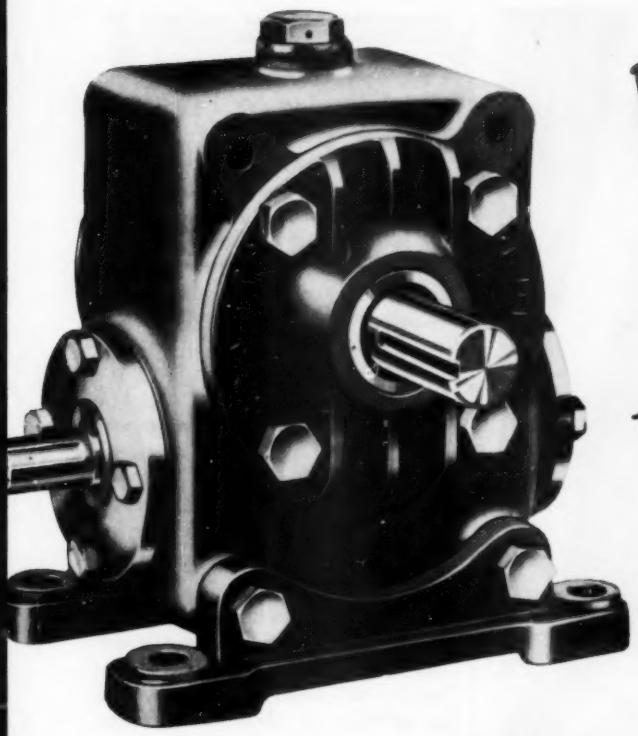


Who says they're good?

THE PEOPLE WHO USE THEM!

A satisfied user is the best indication of a satisfactory product. And people who use Crofts Universal Mounting Worm Gear Reducers tell us they're the best.

They can be mounted anywhere, in almost any position, and left alone to do their job.

Available from stock in sizes 1-1/8", 1-3/4", 2-1/4" and 3" centers. Up to 6 h.p., ratios up to 60:1. Described in Bulletin B-571.

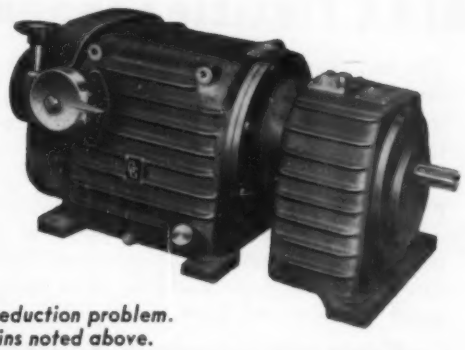
FOOT MOUNTING POSITIONS ALTERNATE

Also from CROFTS...

CARTER HYDRAULIC VARIABLE SPEED GEARS

Carter Hydraulic Variable Speed Gears provide infinite speed variations from input speed for fractional units down to zero r.p.m. in either direction of rotation. Handwheel, remote electrical or lever arrangements provide accurate control. Larger sizes from input speed to zero have 5% reverse direction. Either type will pick up loads from zero r.p.m.—speed control setting can be adjusted with drive running or stationary. All units are compact, easy to maintain and are entirely self-lubricating.

Available from stock up to 5 h.p.; prompt delivery to 35 h.p. Described in Bulletin B-CG.



Ask for recommendations on your speed reduction problem.
For general information, request bulletins noted above.

MAKERS OF:

RITESPEED GEARMOTORS • WORM GEARMOTORS • HELICAL GEAR REDUCERS • MOTOR DRIVEN ROLLERS • HYDRAULIC COUPLINGS & DRIVES • CARTER VARIABLE SPEED HYDRAULIC GEARS • RITESPEED REDUCTION GEARS • WORM GEAR REDUCERS • SPUR & BEVEL GEARS • SPIRAL BEVEL GEAR UNITS—FRICTION CLUTCHES • SHAFT-MOUNTED GEAR UNITS

CROFTS U. S. A. INC.

2542 West Peterson Avenue • Chicago 45, Illinois • Telephone: ROgers Park 1-0019

EASTERN STATES DISTRIBUTOR

Rockwood Pulley Mfg. Co., Inc. • 20 Crosby Street, New York 13, N. Y.

CROFTS CANADA LTD.

2185 Madison Avenue
Montreal 28, P. Q.

25 Jutland Road
Toronto, Ont.

For more information circle No. 9 on the Reader Service Card

Clutch catalog

Describes five standard lines of spring clutches in bore sizes from 1/8 to 1 in. and torque capacity to 1250 lb-in. They are specially designed for use in machinery and instrument applications where drives to 5 hp are used. Series are over-running and backstopping, indexing, on-off and on-off indexing.

Curtiss-Wright Corp., Marquette Div., Cleveland, Ohio.

Circle number 65 on reader service card

Master components catalog

Master catalog 20a consolidates all previous catalogs and supplements, lists over 10,000 items in its 416 pages. Included are gears, shafts, collars, couplings, speed reducers, differentials, and other items from stock. In addition to detailed drawings, complete specifications and prices, catalog contains breadboard kit and precision tool component sections.

PIC Design Corp., East Rockaway, N. Y.

Circle number 66 on reader service card

Self-aligning couplings

Dihedral 3-D couplings have special teeth providing 3 degree total angular capacity or equivalent parallel offset with less tooth clearance than gear-type couplings. Small diamete. for compact, light use. Catalog 65, 8 pages.

Ajax Flexible Coupling Co., Inc., Westfield, N. Y.

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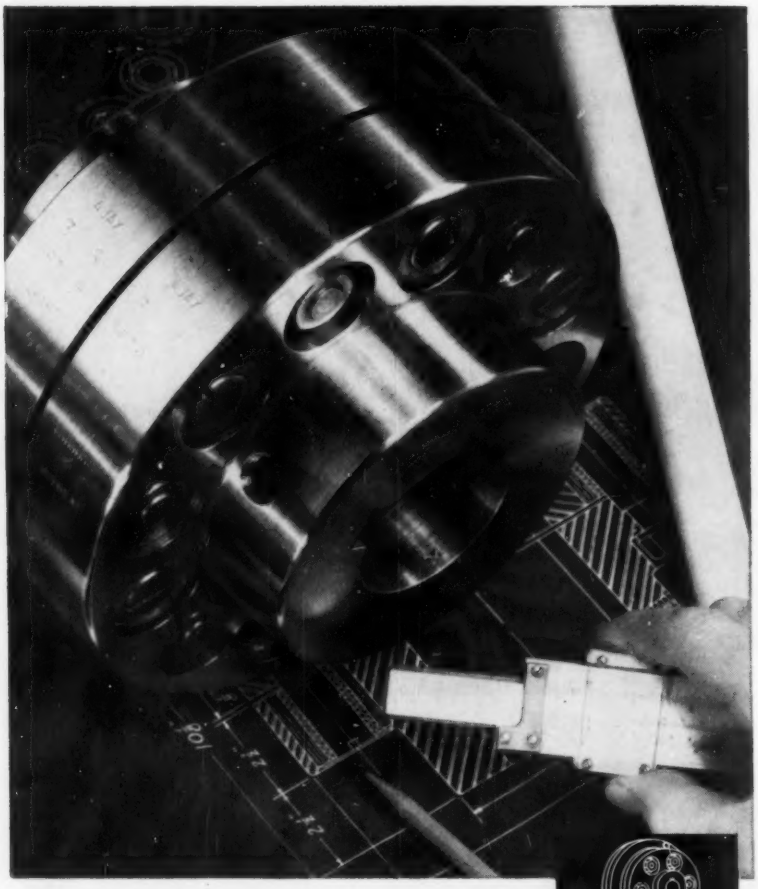
Moduline gear units

Preassembled modules standardize over 20,000 variations of gearmotors, speed reducers and package motor reducer drives. Seven basic frame sizes accommodate these applications, requiring only a standard wrench for assembly. Product bulletin shows versatility of the line.

Westinghouse Electric Corp., Pittsburgh, Pa.

Circle number 68 on reader service card

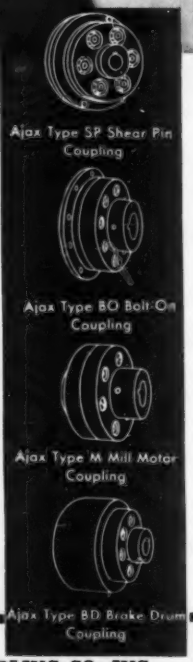


Never Underestimate the Economies of AJAX Flexible Couplings

The fact that *All the Horsepower goes through the coupling* is proof of its importance. In safeguarding performance . . . in reduced maintenance . . . in freedom from breakdowns and costly repairs, Ajax Flexible Couplings add to the reliability, reputation, and economy of the machines you build.

Ajax offers America's most complete line of bronze bushed, rubber cushioned and Dihedral gear type couplings available from stock for heavy machine and light duty service.

Write for complete engineering and selection data.


Ajax Type SP Shear Pin Coupling
Ajax Type BO Bolt-On Coupling
Ajax Type M Mill Motor Coupling
Ajax Type BD Brake Drum Coupling

AJAX

AJAX FLEXIBLE COUPLING CO. INC.
132 English St., Westfield, N. Y.
Send catalog covering Flexible Couplings.

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Concern _____
Address _____

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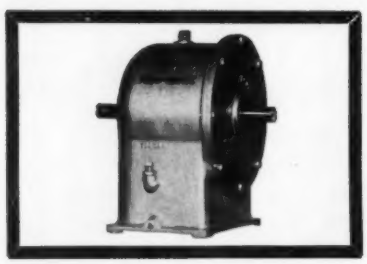

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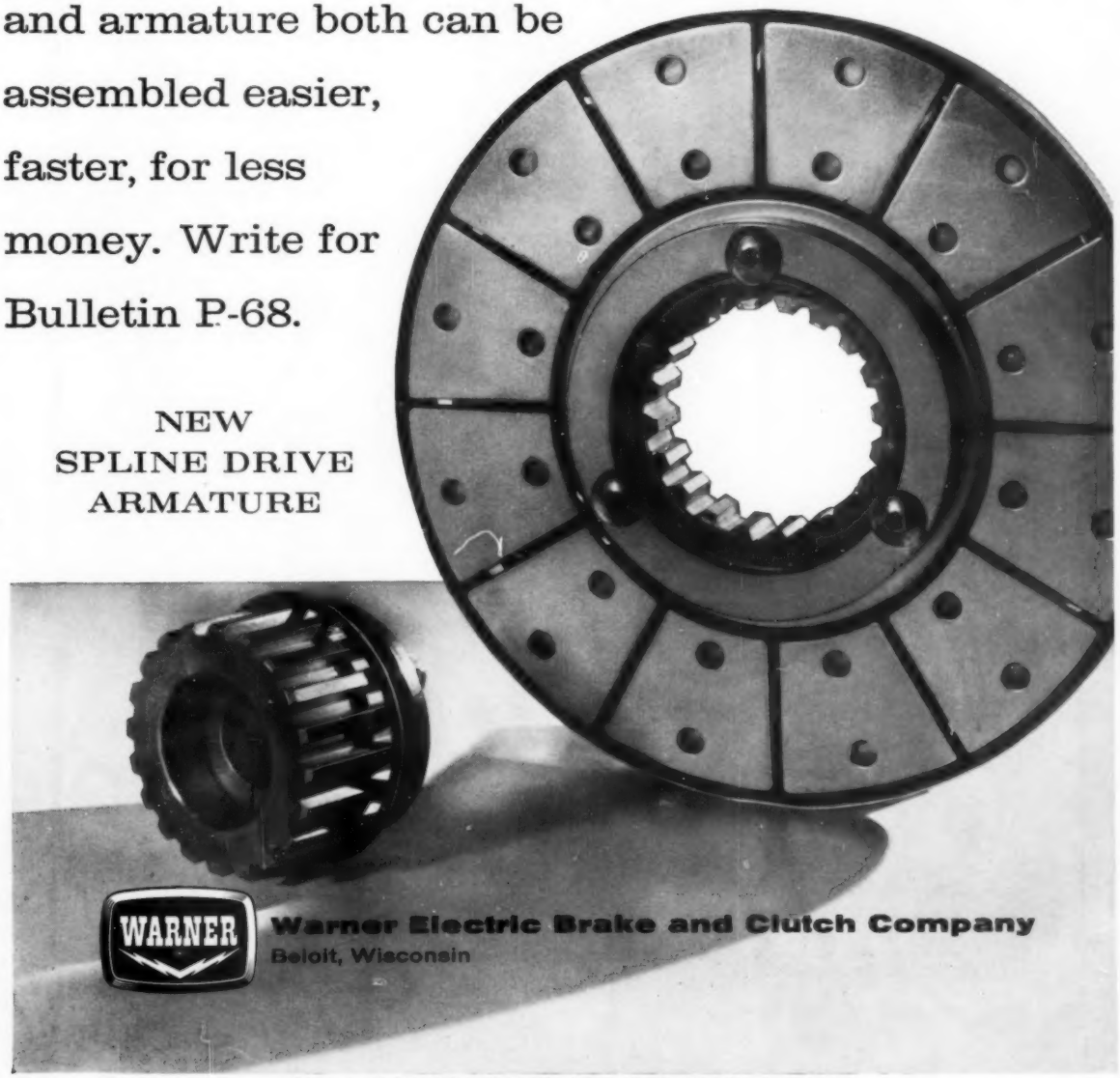

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